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Memoirs

OF THE

British Astronomical Association.

EDITED BY

E. WALTER MAUNDER, F.R.A.S.

REPORTS

OF THE

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SECTION FOR THE OBSERVATION

OF

METEORS.

DIRECTOR.—HENRY CORDER.

REPORT OF THE SECTION, 1897.

Introductory.

The past year has been one of the most disappointing which this Section has experienced. The moon was near the full on the occasion of most of the principal showers, and cloudy weather also interfered to quite an unusual extent.

Fortunately it was clear at the time of the January Quadrantid shower, and some good observations were obtained; but the later showers were of feeble intensity, and the Leonids, of which great things were hoped, were scarcely observed at all.

Under these circumstances it is hardly worth while to print a list of Members of the Section as so little has been done, but it is to be hoped that during next autumn when the moon will be absent, the weather also may be propitious. However, the Director desires to thank all who have assisted in whatever could be done, and also to acknowledge Mr. W. F. Denning's kindness in furnishing the interesting details of a number of bright meteors, most of which were seen by some of our Members.

Bridgwater,
February 25, 1898.

HENRY CORDER,
Director.

Meteor Showers, 1897.

JANUARY QUADRANTIDS.

The first two or three nights of the year are not often the best for meteoric observation, and consequently this shower is seldom well observed. It seems also to be of short duration, and the maximum is soon passed. Fortunately it was fine on the last night, that of January 2nd, with clear intervals on other nights near that date, and some unusually good observations were thus secured.

Mr. Backhouse began his watch at midnight on December 30th, but no Quadrantids appeared, and only one in about a quarter of an hour just before daybreak the next night.

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On January 1st Mr. Backhouse commenced watching in the evening twilight when one or two meteors appeared, and watches from a quarter to half-an-hour's duration were maintained at intervals all night, when a total of 97 meteors was secured. In the early morning hours, especially between $17{\cdot}0^h$ and $19{\cdot}0^h$ the rate of meteors was very high, almost up to one per minute. Nearly all of these were Quadrantids, and Mr. Backhouse computes that the zenithal horary number was as high as 64, about $17^h\ 15^m$. Of these 97 meteors 25 were considered to be of magnitude 0, five being equal to Sirius, and two rivaling Jupiter in brightness.

On the next two evenings in short watches only two meteors were seen. As this series of observations is one of the finest ever made of this shower, Mr. Backhouse's complete table is appended.

WATCH FOR METEORS OF THE QUADRANTID SHOWER.

By T. W. BACKHOUSE.

Chiefly at Sunderland.

Explanation of Contents of Columns in Tables.

Time—beginning and ending of each look out; O—the number of minutes of observation in the interval; Sky—the proportion of clear sky in the direction of observation; O^1—the minutes of observation corrected for cloud; Hindrance—the other hindrances to visibility of meteors; Mag. vis.—the magnitude of the faintest stars visible in spite of these hindrances; F—the number of falling stars seen; R—their rate per hour; Q—the number of Quadrantids; Alt.—the altitude of the radiant point at middle time; $O^2 = O^1 \times$ sine alt.; and Q^1 is the rate per hour of Q upon O^2, or the zenithal horary number of Q, only that meteors whose directions were unknown have been counted as Quadrantids in the column headed Q^1, and are added in that headed Q.

Date and Time.	O.	Sky	O^1.	Hindrance.	Mag. vis.	F.	R.	Q.	Alt.	O^2.	Q^1.
1896, Dec. 30: h m h m									°		
11.58 to 12.21	10	·7	7	——	—	2	17	—	22	2·6	—
12.35 „ 12.50	5	·4	2	——	—	0	—	—	24½	0·8	—
17.36 „ 17.38	2	·4	1	——	—	0	—	—	60½	0·9	—
Total	17	—	10	——	—	2	12·0	0	—	4·3	—
1896, Dec. 31:											
10.38 to 10.52	12	·9	11	——	—	0	—	—	16	3·0	—
14.20	2	1·	2	——	—	0	—	—	35	1·1	—
18.7 to 18.29	17	1·	17	——	—	1	4	1	66½	15·6	3·8
Total	31	—	30	——	—	1	2·0	1	—	19·7	3·0

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Date and Time.	O.	Sky	O¹.	Hindrance.	Mag. vis.	F.	R.	Q.	Alt.	O².	Q¹.
1897, Jan. 1: h m h m									°		
4.54 to 5.20	18	1·0	18	Very bright twilight.	—	2	7	1+1	24	7·3	6·4
5.20 „ 5.30	9	1·0	9	Bright twilight -	—	0	—	—	23	3·5	—
5.56 „ 7.2	20	1·0	20	—	—	1	3	1	18	6·2	9·7
9.0 „ 10.28	25	1·0	25	—	—	2	5	2	14	6·1	9·7
11.0 „ 12.4	26	1·0	26	—	—	3	7	1	19	8·4	7·1
12.20 „ 12.56	26	1·0	26	—	—	7	16	5	24½	10·8	27·8
13.13 „ 13.53	17	1·0	17	—	—	4	14	3	29½	8·4	21·4
15.20 „ 16.30	20	1·0	20	—	—	6	18	6	46	14·4	25·0
16.31 „ 17.7	18½	1·0	18½	—	—	17	55	15+1	54	15·6	64·0
17.8½ „ 17.33	18	1·0	18	—	—	13	43	13	58½	15·3	51·0
17.35½ „ 18.11	31	1·0	31	—	—	23	45	19+1	62½	27·5	43·7
18.14 „ 18.40	21	1·0	21	—	—	17	49	15	67½	19·4	46·4
18.43½ „ 18.49	5½	1·0	5½	Twilight - -	5½	2	22	2	71	5·2	23·1
Total -	255	—	255	—	—	97	22·8	83+3	—	147·5	35·0
1897, Jan. 2:											
6.10 to 6.24	7	1·0	7	—	—	0	—	—	19	2·3	—
6.24 „ 6.28	4	1·0	4	Town-light -	—	0	—	—	18	1·2	—
Between Sunderland and Stockton: 6.40 to 7.21	6	1·0	6	—	—	1	10	1	16	1·7	35·3
Total -	17	—	17	—	—	1	3·5	1	—	5·2	11·5
At Stockton, 1897, Jan. 3: 8.15 to 8.45	11	·9	11	—	—	0	—	—	14	2·7	—
8.55 „ 9.15	7	·9	6	Thin cloud -	—	0	—	—	14	1·5	—
Total -	18	—	17	—	—	0	0	—	—	4·2	—
Grand Total	338	—	329	—	—	101	18·4	84+4	—	180·9	29·2

At Bridgwater the Director watched for an hour in the early evening, but only five meteors were seen. Another engagement prevented further observation until 10.30, and then only two were seen in a few short watches. One of these was a fine one in the S., magnitude 0, orange in colour, with a lasting streak. At 11.20 watching was commenced in earnest, and kept up almost without a break until 16.40, though fog came on for a time after midnight, but fortunately cleared off again. About six hours were fairly clear, and 130 meteors were seen, of which 109 were Quadrantids. Of these only two were reckoned equal to Jupiter, and they merely left faint streaks, being very different from the Leonids and Perseids in this respect, a very small proportion

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having any train or streak. In only four was any colour noted, and these were orange and yellow. Either Mr. Backhouse had better fortune in seeing bright meteors, or, what is possible, the Director may be over cautious in the matter of magnitude, but the following figures show a small proportion above 1st magnitude. The second figure indicates the number of streaks in each group.

Mag.	>1.	1.	2.	3.	4.	5.	Coloured.
No.	3·3	11·4	22·6	50·3	18·0	5·0	4

The radiant was very diffuse. In some years the finest and longest meteors have seemed to come from a point in Hercules. This time it was scarcely recognised, or perhaps the area of the Quadrantids included the Herculid shower. They may be really connected, but the lasting streaks sometimes seen are generally from Herculids. The radiant area was, perhaps, triangular, measuring 10° or 15° along each side. The centre was at about 230° + 51°, but the most distinct positions were—

Quadrans	224 + 49
Draco	235 + 55
Hercules	234 + 49

The following table shows the hourly number of the meteors as observed, without any allowance for fog or loss of time.

Hour.	——	No. of Meteors.	Quadrantids.
h m h m			
6 30 to 7 30	—	5	3
10 30 „ 11 20	Intervals	2	2
11 20 „ 12 20	Clear	14	10
12 20 „ 13 20	Foggy	14	10
13 20 „ 14 15	15m lost through fog.	12	8
14 15 „ 15 15	Fairly clear	32	30
15 15 „ 16 15	Clear	39	34
16 15 „ 16 40	Foggy at end	12	12
About six hours clear.		133	109

It will be seen by comparing the above with Mr. Backhouse's table that the best of the shower was lost at Bridgwater by fog coming on at 16h 30m.

The subsequent nights were almost overcast, and no more were seen.

Prof. A. S. Herschel watched at Slough for the hour before midnight and saw seven meteors, of which four were Quadrantids. Radiant reckoned at 235° + 57°.

Mr. J. A. Hardcastle watched for about an hour after dark, and saw six meteors, all Quadrantids, and again for about two hours preceding midnight, when 12 more were seen, eight being Quadrantids. Two radiants were determined at 224° + 52° and 235° + 57°, agreeing fairly with those seen at Bridgwater. One, at 11.22, was rated as equal to Sirius or Jupiter.

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Very few other meteors were seen by any of the Section in January; the chief shower at the end of the month was one of seven meteors from δ Cancri.

FEBRUARY.

Mr. Besley obtained a few good observations at the end of the month, and found a radiant of Coronids (five meteors) at $227\frac{1}{2}° + 27°$. It is probable that there are at least two distinct showers in this constellation in the spring, but this position agrees very nearly with the May shower.

MARCH.

Cloudy, and very few meteors seen. A few of the long Virginids from $199° - 10°$ were mapped at the end of the month.

APRIL.

Almost a complete failure this year, and no Leonids seen.

MAY.

A watch kept for Aquarids, but only two seen, one was a very fine one of great length. There was also a shower of star-like meteors from β Libræ ($232° - 9°$).

In June nothing was done, and in July little was seen until the end of the month, when a few Aquarids were noted, but it is evident that this shower has quite dwindled away. A few early Perseids were also mapped, and a few from near θ Aquilæ.

AUGUST.

It will not be worth while to write a detailed account of the Perseid shower, as it was not well observed, owing to the moonlight and cloudy weather. It would not appear, however, to have been a brilliant shower, for when opportunities did occur very few were visible. A list of radiants is given in the general table, showing a marked eastward movement from the end of July until the middle of August.

On August 3rd Mr. Besley was watching from 10^h until 15^h, and saw 27 meteors, of which only six were Perseids.

August 9th was the only really good chance, and Mr. Besley recorded 109 meteors between $9^h\ 53^m$ and $15^h\ 19^m$, of which 49 were in one hour (14^h–15^h). Of the total, 72 were Perseids with a radiant at $45° + 57°$. There was also a well marked shower of swift meteors from Taurus, seven in all, from $52\frac{1}{2}° + 15°$, and minor showers in Camelus and Lacerta. At Bridgwater it was not so clear, but the Director watched from $13^h\ 20^m$ to $15^h\ 20^m$, and counted 47 meteors with an hourly number of Perseids of 17 and 19. The radiant was well defined at $45° + 57°$, which agrees well with Mr. Besley's.

August 10th was very overcast, and the 11th partly so, and also there was a bright moon. Several watched for short intervals, but meteors were very scarce, only four meteors being seen between 10.30 and 11.30. Ten Cassiopeids were seen from $16° + 56°$, but they were of insignificant appearance, and possibly do not represent the strong shower of 20 years or so ago.

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SEPTEMBER.

A few watches kept, but not many meteors were seen. The Piscids had commenced feebly towards the end.

OCTOBER.

The commencement of the Orionid period was cloudy and moonlight, but matters improved later, and a few good observations were made.

The first Orionid seems to have been recorded in an evening watch on October 19, at Bridgwater, when eight meteors were seen in about an hour.

October 20 was clear, and Mr. Besley watched between $10^h\ 30^m$ and $13^h\ 15^m$, but only saw 10 meteors, of which four were Orionids. At Bridgwater an evening watch of an hour's duration only produced seven meteors, none of them Orionids, so it was decided to wait until the morning, when 27 more meteors were seen, of which 14 were from the combined radiants in Orion and the feet of Gemini. It is not easy to decide as to whether these are truly separate showers, but it is possible that they are so, as the Orion radiant is always extremely well defined and stationary, and generally somewhat earlier in action. The Geminid showers, on the contrary, are several in number, stretching in a vertical line over eight or ten degrees. It is not easy to separate the meteors, so they are all classed together in the following tables.

Date.	Time.	Total.	Orion-Geminids.
	h m h m		
October 20 - -	9 0—10 15	7	0
" - -	14 25—15 30	11	4
" - -	15 30—16 30	9	6
" - -	16 30—17 30	7	4
		34	14

On October 21 Mr. Besley watched from 11^h to $12^h\ 15^m$, but only saw four meteors. At Bridgwater 37 meteors were counted.

Date.	Time.	Total.	Orion-Geminids.
	h m h m		
October 21 - -	10 30—11 30	3	1
" - -	11 30—12 30	9	2
" - -	12 30—13 30	11	5
" - -	13 30—14 30	14	3
		37	11

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So it will be seen that there was not a strong display. On each morning a meteor as bright as Sirius appeared. That at $13^h\ 6^m$ on the 21st was orange with a green streak.

Most of Mr. Besley's meteors, which belonged to the combined showers, were true Orionids from $91° + 15\frac{1}{2}°$, but at Bridgwater most were Geminids chiefly from near γ at $96° + 18°$.

On October 28 another watch was kept, and 37 meteors seen in four hours. It was hoped that the Arietids would have appeared, but only about five were seen, even including Taurids. Most of the rest were very sporadic, with no marked radiant.

On October 29 Mr. Besley watched for an hour and a half, but only saw nine meteors. A few were Taurids.

NOVEMBER.

Reports were received from a number of Members of the Section and others, concerning the Leonids, but owing to the moonlight and bad weather it was only a record of failure, more or less complete.

Some patient observers sat watching a perfectly blank sky, others a dazzling moon, but none of them saw anything which could be called a shower of meteors at any rate.

Mr. Besley, in London, was the most successful, for he saw 27 meteors on November 13, $12^h\ 43^m$—$17^h\ 52^m$, of which 21 were Leonids with a very well defined radiant at $149° + 23°$. Of these, one at $15^h\ 53^m$ was equal $\mathcal{U}$, and another two minutes earlier was rated at 1st magnitude, and left a conspicuous green streak. Mr. J. H. Bridger watched at Farnborough, and saw nine meteors, several of which were Leonids.

Miss Orr, at Camberley, saw four meteors, but perhaps only two were Leonids. No others of our Members report anything worth recording, but some people in Scotland appear to have seen a brisk shower before sunrise on November 15.

No Andromedes were seen, and the Taurid shower was not at all a strong one.

The chief watch kept at Bridgwater was on November 3, from $13^h\ 15^m$ until about 17^h, and 50 meteors were seen, but there was no very marked radiation.

During the month 13 Taurids were seen from about $59° + 24°$, the radiation not being so distinct as in recent years. There were in all 11 Arietids from $43° + 15°$.

DECEMBER.

Bright moonlight interfered with the Geminids and very few were seen. As these meteors are generally very small and short, they are easily lost on a light sky. Mr. Bridger saw three Geminids on December 10 in five minutes, but no others in an hour, and one was seen on the 12th.

At Bridgwater four only were seen, though observations were attempted on December 10th, 11th, and 12th.

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Radiants of Meteor Showers, 1897.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1897.		° °			
714	Jan. 1–2	Quadrantids	224 + 52	4	Swift	J. A. H.
715	„ 1–2	„	224 + 52	4	Swift	A. S. H.
716	„ 1–2	„	235 + 57	—	Swift	J. A. H.; A. S. H.
717	„ 1–2	„	224 + 49			
718	„ 1–2	„	234 + 49	109	Swift	H. C.
719	„ 1·2	„	235 + 55			
720	„ 1–2	Leo Minor	133 + 33	3	Quick	A. S. H.
721	„ 23–24	δ Cancri	126 + 19	7	Quick	H. C.
722	„ 23–24	Monoceros	109 + 1	3	Quick	H. C.
723	„ 23–24	„	95 + 4	2	Quick	W. E. B.
724	„ 23–24	Hydra	139 + 5	3	Quick	W. E. B.
725	Feb.	Auriga	90 + 38	4	Quick	W. E. B.
726	„	Leo	150 + 9½	3	Quick	W. E. B.
727	„	Ursa	147 + 45	3	Quick	W. E. B.
728	„	Corona	227½ + 27	5	Quick	W. E. B.
729	Mar.	Canes V.	187 + 35	4	Quick	H. C.
730	Mar.–Apr.	α Virginids	199 − 10	6	Slow	H. C.
731	Apr.	Arcturids	211 + 21	3	Slow	H. C.
732	Apr.–May	Polarids	225 + 86	4	Quick	E. R. B.
733	„ „	Quadrantids	214 + 50	5	Quick	E. R. B.
734	„ „	Serpentids	230 + 16	4	Slow	E. R. B.
735	May 3	β Libids	232 − 9	6	Slow	H. C.
736	July–Aug.	θ Aquilids	300 − 5	5	Slow	H. C.
737	„ „	Equuleus	312 ± 0	3	Quick	H. C.
738	„ „	ζ Cygni	318 + 28	4	Quick	H. C.
739	„ „	Equuleus	311 + 3	3	Swift	H. C.
740	„ „	Lacerta	330 + 50	3	Quick	H. C.
741	„ „	„	340 + 50	5	Quick	W. E. B.
742	„ „	Camelus	80 + 80	3	Quick	H. C.
743	„ „	α Aurigæ	78 + 52	3	Swift	W. E. B.
744	„ „	o Piscium	22 + 11	3	Swift	W. E. B.
745	„ „	Cepheus	344 + 55	4	Quick	W. E. B.
746	July 25	Perseids	22 + 52	4	Swift	H. C.
747	„ 30	„	37 + 53	4	Swift	H. C.
748	Aug. 1	„	30 + 56	4	Swift	E. R. B.
749	„ 3	„	32½ + 57½	6	Swift	W. E. B.
750	„ 9	„	45 + 56	16	Swift	W. E. B.
751	„ 9	„	45 + 57	30	Swift	H. C.
752	„ 3	γ Andromedæ	22½ + 42	8	Swift	W. E. B.

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B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1897.		° °			
753	Aug. 3 -	ζ Persei -	56 + 31	3	Swift - -	W. E. B.
754	„ 2 -	Cassiopeia -	39 + 65	3	Swift - -	W. E. B.
755	„ 2 -	Triangulum -	27 + 35	3	Quick - -	W. E. B.
756	„ 2 -	Cassiopeia -	16 + 56	10	Quick - -	H. C.
757	„ - -	η Aquarii -	338 + 3	3	Slow - -	H. C.
758	„ 2–9 -	λ Piscium -	354 + 1	3	Slow - -	H. C.
759	„ - -	τ Ceti - -	20 − 15	3	Swift - -	H. C.
760	„ 9 -	Taurus -	52½ + 15	7	Swift - -	W. E. B.
761	„ 9 -	Camelus -	72½ + 67½	5	Swift - -	W. E. B.
762	Sept. -	γ Pegasi -	8 + 16	3	Slow - -	H. C.
763	Sept.–Oct. -	η–θ Ceti -	19 − 11	3	Slow - -	H. C.
764	„ „ -	Lynx - -	123 + 34	4	Swift - -	H. C.
765	„ „ -	β Tauri -	82 + 32	3	Swift - -	H. C.
766	„ „ -	θ Ursæ -	135 + 63	5	Quick - -	H. C.
767	„ „ -	Custos -	35 + 71	5	Quick - -	H. C.
768	„ „ -	Piscids -	359 + 3	4	Slow - -	H. C.
769	Oct. - -	„ -	354 ± 0	5	Slow - -	H. C.
770	„ - -	Cetids - -	30 + 10	4	Slow - -	H. C.
771	„ 19–21 -	Orionids -	91 + 15½	9	Swift - -	W. E. B.
772	„ 19–21 -	„ -	94 + 14	5	Swift - -	H. C.
773	„ 19–21 -	γ Geminids -	96 + 18	20	Swift - -	H. C.
774	„ 19–21 -	„ -	100 + 19			
775	„ 19–21 -	ξ Geminorum	97 + 13			
776	„ 19–21 -	μ Geminorum	96 + 22			
777	„ - -	α Arietids -	27 + 23	4	Slow - -	H. C.
778	„ - -	Cepheids -	300 + 55	6	Slow - -	H. C.
779	„ - -	ι Aurigæ -	74 + 31	7	Quick - -	H. C.
780	„ 28 -	ζ Tauri -	86 + 26	6	Swift - -	H. C.
781	„ 28 -	ζ Geminorum	106 + 22	4	Swift - -	H. C.
782	Oct.–Nov. -	ι Ursæ -	132 + 48	3	Quick - -	H. C.
783	„ „ -	Arietids -	43 + 15	11	Slow - -	H. C.
784	Nov. -	Taurids -	59 + 24	13	Slow - -	H. C.
785	Oct.–Nov. -	„ -	61 + 23	3	Slow - -	W. E. B.
786	„ „ -	Taurus -	75 + 15	3	Slow - -	W. E. B.
787	Nov. -	Leonids -	149 + 23	21	Swift - -	W. E. B.
788	„ -	Canes Venat -	201 + 44	4	Swift - -	W. E. B.
789	Nov.–Dec. -	Telescopium -	96 + 42	6	Quick - -	H. C.

Observers.—E. R. B. BLAKELEY. H. C. CORDER.
T. W. B. BACKHOUSE. J. A. H. HARDCASTLE.
W. E. B. BESLEY. A. S. H. HERSCHEL.

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BRIGHT METEORS OBSERVED DURING 1897.

Date.	Time.	Mag.	Remarks.
1897.	h m		
Jan. 1 -	10 47	>1	From 115° + 5° to between α-β Canis Majoris, orange with green streak. Quadrantid.—H. C.
„ 1 -	13 43	4	From 20° + 70° to 34° + 54°. Faint streak. Quadrantid.—H. C.
„ 1 -	15 35	4	From 84° + 52° to 79° + 41°. Streak. Quadrantid.—H. C.
„ 8 -	7 20 Malta time.	♀	From 3h. 20m. + 40° to near β Ceti. Very slow. Red and blue, with spark train. REV. T. H. FOULKES, Malta.
„ 23 -	7 23	♂	Orange. Slow, with trains and sparks.—H. C.
Apr. 22 -	10 24	>1-4	Very slow. 7 secs. Blue at first, flashed out red at last. Disintegrated into sparks.—E. R. B.
„ 30 -	9 37	5×♀	From 166° + 51° to 156° 35°. Radiant. 291° + 59°.—W. F. DENNING.
May 5 -	10 1	>1	From 234° + 15° to 214° + 19°. Slowish. 2 secs. Golden yellow. Slight train.—G. F. DAVIS.
„ 5 -	12 32	> Vega	From 16h. 30m. + 43° to 19h. 13m. + 64. Greenish train, 5° long.—H. R. MAYNARD.
July 10 -	11 30	♂	Near α Ophiuchi, bursting into fragments.—C. WHYTE, Dunrossness, Shetland.
„ 14 -	11 10½	>♂	From about 2° S.W. of γ Pegasi, passed 5° above α and went 5° further. 2½ secs.—REV. S. J. JOHNSON.
„ 25 -	10 20	4	From 177° + 26° to 168° + 24°. Green, with orange train. Radiant, η Aquilæ?—H. C.
„ 29 -	7 0	☾	Fell from a few degrees E. of zenith to near E. horizon Pear-shaped, size of moon; in sunshire. — Per G. F. D.
Aug. 2 -	13 50	Sirius	From 9° + 25° to 342° + 65°. Streak.—H. C.
„ 2 -	13 87½	♀	From 310° + 33° to 309° + 49°. Breaking out with greenish flashes and leaving a knotted streak.—H. C.
„ 4 -	10 30	♀	Directed from ¾° (α, δ) Ursæ Minoris, passed ¼° E. of κ Cephei. Course about 12°. Brightening. Red train.—T. W. BACKHOUSE, Scarbro'.
„ 11 -	10 4	4	From 7° E. of α Ursæ Majoris, crossed that star, vanished half way to γ.—REV. S. J. J.
„ 11 -	10 8	♀	From δ Cassiopeiæ, passed ¼° beneath E., went on 15° to W.—REV. S. J. J.
„ 17 -	9 4	Sirius	Directed from Polaris, passed ½° (δ, γ) Ursæ Majoris, disappearing behind house 10° further.—T. W. B., Sunderland.
Sept. 21 -	7 22	>1	Falling down line joining γ Cassiopeiæ and Capella. First seen half way between and ending near Capella. Distinct train.—J. R. FOTHERINGHAM, Sigglesthorne, Hull.
„ 27 -	9 40	♀	Lasting streak.—H. C.
Oct. 2 -	7 48	Sirius	From 282° + 33° to 231° + 26°. Slow. Bluish. Red train. Piscid. Long path.—H. C.
„ 20 -	12 20½	>1	From 71° + 15° to 58½° + 15°. Swift. Streak. White.—W. E. B.
Nov. 13 -	15 53	4	From 163½° + 12° to 177½° − 0½°. Streak. Leonid.—W. E. B.

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Date.	Time.	Mag.	Remarks.
1897.	h m		
Nov. 18 -	5 30	>♀	From 322° + 8° to 326° − 6°. Rapidly increasing in brightness.—D. E. F.
„ 28 -	8 18	> 1	From 230° + 69° to 243° + 63°. J. E. CLARK, Croydon.
Dec. 1 -	5 15	♀	Brilliant white, near α Piscium, fell about 10° S. of that star, bursting into fragments.—C. WHITE.
„ 12 -	± 7 10	Sirius	Low down in Aquarius, a small green fireball with short train. ? β Taurid.—H. C.
„ 12 -	20 30	☾	Seen in daylight in E.N.E., moving S. Path about 20° in length. Greenish blue, with train of sparks and flame breaking from it.—J. T. POPE, Dingwall.

Doubly Observed Meteors, &c., 1897.

QUADRANTID = ♇ OF JANUARY 1ST, 1897.

The following double observation of a Quadrantid by Prof. A. S. Herschel and Mr. J. A. Hardcastle at 11·22, January 1st, is interesting on account of the nearness of the two observers to each other. As before shown, this makes the result less reliable, but as a lesson in working out the true paths of meteors it is worth giving in Prof. Herschel's own words. "The base-line "from Basingstoke to Slough is only 27 miles; but the two "mapped tracks of the bright Quadrantid at 11.21½ or 11.22 were "in excellent parallax agreement, giving a real path from 68 miles "over 2 miles E. of East Grinstead, to 42 miles over 5 miles S.S.W. "from Worthing; sloping path 42 miles in 2½ seconds, velocity "17 miles per second from a radiant at 190° or 200° + 62°, then "at altitude 39°, 32° E. from N., whose remoteness from the "Quadrantid radiant is not dependable, because both the tracks' "backward prolongations pass (on opposite sides) within two or "three degrees from 235° + 57°, but being very little divided "from each other by parallax, they happen to intersect (at a very "acute angle) a good many degrees before reaching that point; and "a lateral correction of less than a degree to either the end or "the beginning point of both the observations would make the "tracks prolonged backward intersect at 235° + 57°, instead of "at about 195° + 62°. The altitude of the radiant or slope of "path would be lowered then from 39° to about 20°, and if the "small corrections were made to the end points, the end height "would be raised from 42 to about 50 miles or more, and the "point of disappearance would become more distant from the "fixed beginning point and from Slough and Basingstoke than "before, and the length of path and velocity would be largely "increased, and the latter would no longer fall so short then, as "it appears to do at present (17 miles per second), of the real "meteor speed (25 miles per second) of the Quadrantids with "their radiant point at 235 + 57."

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METEOR OF FEBRUARY 18th, 1897.

The Rev. T. H. Foulkes writes from Malta:—"Last night ± "6.17 p.m., Malta time, 58m fast of G.M.T., one of the grandest "and finest meteors I ever saw. It started about midway "between Castor and Capella, and moved very slowly in a N.W. "direction. There were no stars visible to enable me to give a "better course. The shape was pearlike, the base (*f* end) was a "lovely glowing orange-red, such as I have never seen before; "the head was intensely white. Little train. If it had been "dark the whole place would have been lighted up by this "brilliant object. The size I cannot estimate; quite four times "as bright as Venus is now."

METEOR OF APRIL 30th, 1897.

Mr. Charles Upton writes from Tower House, Stroud:—"An "extraordinarily fine meteor was observed here on April 30th, at "about 9h 38m. The meteor first became visible near η Ursæ "Majoris, passed near to γ Leonis, and eventually died out on the "confines of Hydra. The colour of the meteor was an intense "bluish white, like an arc light very much elongated, and it left "a trail of light for a considerable distance behind it, lasting two "or three seconds. The brilliancy of the meteor was so great "that the place was lit up almost as by a flash of lightning." As will be seen from Mr. Denning's table, this meteor was a Draconid with a path of 70 miles, varying from 59 to 18 miles above the earth, with a velocity of 23 miles per second.

METEORS OF AUGUST 18th, 1897.

The Rev. T. H. Foulkes, at Malta, saw two curious meteors on this evening. The first, at 7.55 Malta time, was in Aquila, moving very slowly from 19h + 5° to 20h 30m + 10. The train appeared like an elongated mass of red-hot cinders.

The second was at 10.30 in Ursa Minor, and appeared about midway between Polaris and γ–β Ursæ Minoris; shape unique, exactly like a starfish with five fingers, and was of a brilliant red colour.

FIREBALL OF JUNE 10th, 1897.

Described by Rev. S. J. Johnson, of Melplash Vicarage, as "a "small fireball at 9.29¾ on June 10th, Friday." (This should probably be June 11th, *see* following account.) "It was too much "in the twilight to record the track. E.S.E. sky, altitude 15° at "appearance, went downward perpendicularly to 10°, about 30° "S.W. of Vega. Pear shaped, about ⅕ of the size of the moon. "Colour, white tinted with green and red."

Mr. G. B. Longstaff, then at Morthoe, North Devon, says:—"On "Friday last, June 11, at about 9.30, while it was yet quite light, "it being three days before full moon, I saw a very brilliant "meteor. The sky was so light that it was not easy to fix the "position of the meteor, and it was not seen through the whole "of its course. It was in the southern sky, about 20° E. of the "moon. It was below Saturn, and I think to the W. of Antares. "I saw it pass through about 12° and reach the horizon, either

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" vertically or sloping from W. to E.; its motion was rather slow. " Brilliance at least equal to that of the moon; I think decidedly " brighter. Colour, bluish white, size larger than Venus at its " brightest; there was no train or streak, and no report was " heard."

FIREBALL OF JULY 30th, 1897.

It will be seen from Mr. Denning's table that he received at least seven reports of this fine meteor. Owing to the twilight some of the details may be inexact, but it would appear to have been directed from near β Ursæ Majoris, from a height of 54 miles, along a path 50 miles long to a height of 23 miles over the channel, at a rate of only 13 miles per second.

My own observation of it was that it fell in the S., at 8.48, and when first seen was at about the altitude of Altair, and not far to the east of it, say at 302 + 15. In about $2\frac{1}{2}$ seconds it fell down to within about 8° of the horizon. It was at first of a brilliant bluish white, and considerably brighter than Venus, and faded away, dying out as a few orange flakes.

METEOR OF SEPTEMBER 12th, 1897.

Mr. George Earngey, writes from Deniliquin, N.S.W.:—" On " Sunday last, September 12, at 8.20, a fireball was observed here. " The sky was overcast with the exception of 10° of altitude along " the E. horizon. A glare was first noticed through a small rent " some 15° above horizon, and a fireball shot from behind the " clouds. It was the shape of an Indian club, and in size about " 3 diameters of Jupiter. Its motion was rapid; its fall through " the 10° of arc could not have lasted longer than two or three " seconds. In colour it was a brilliant white opal, while the tail " part was of an Antares red, and somewhat disjointed. In its " course there were two distinct pulsations or dilations, and its " breadth at these times was somewhat greater than half the " diameter of the moon. The meteor appeared to stop at each " dilation, and the appearance was as of flame. The path was " from near δ Aquarii towards ω Piscium in a N.E. course."

METEOR OF SEPTEMBER 16th, 1897.

Another brilliant meteor in the favoured skies of Malta is thus described by Rev. T. H. Foulkes:—" I saw last night, at 11.15 " (local time), one of the finest meteors it has ever been my good " fortune to observe. It travelled very swiftly, and seemed very " near the earth. It appeared to be of the size of the moon, and " four times as bright as Venus. Its enormous head was of a " red and blue colour, with a granulated train, which was curved " and of great length, the central portion was greatly enlarged. " The meteor started near Polaris, and vanished near α Lyræ, " and in its passage lighted up the sky in spite of moonlight."

METEOR OF NOVEMBER 20th, 1897.

This meteor was observed by Mr. Fotheringham, at Sigglesthorne, near Hull, and was remarkable for its long track, of which about 90° was observed from a point in Cassiopeia to 251° + 12°

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in Hercules, which it performed in four or five seconds. The motion was curiously jerky and zigzag, describing a small path with diminishing velocity, then almost stopping, turning through a small angle, and starting on again. This was repeated four or five times at least. The brightness was equal to that of Jupiter or Venus.

FIREBALL OF DECEMBER 12th, 1897.

No record of this great meteor, details of which are given in Mr. Denning's table, reached me directly, but I quote from a letter from Mr. E. R. Blakeley to the "Yorkshire Post" of December 16. "The time of appearance was $8^h\ 5\frac{1}{2}^m$, and it "traversed a fairly long path in the eastern sky, where only "Capella was visible, owing to fog and cloud, but it was evident "that the radiant point was in Taurus. I should estimate the "duration of flight at five seconds, and it moved decidedly slowly, "appearing orange red at first, and expanding with a bright "flash (like moonlight breaking out of clouds), and at the same "time changing its colour to yellowish green. Apparent size "one-fourth of the moon." Other observers in Yorkshire speak of its final explosion, at which time it threw out a shower of sparks. An observer at Ilkley heard a distinct rushing sound like a rocket. This is an assertion often made, and even that sound was heard before a meteor was noticed by the eye. It seems impossible that anything could be heard from such a distance, unless meteors make a "rushing sound" before they become visible, which does not seem likely, or that there is some other way of our appreciating sound than by the ordinary aerial vibrations. Of course it is generally assumed that such sounds being known to accompany the flight of a rocket, one is apt to ascribe them also to meteors, although non-existent as far as the observer is concerned. All such phenomena, however, should be carefully recorded. It will be seen that the meteor began at a height of 112 miles over the North Sea, and descended to only 19 miles above Thirsk, a real path of 151 miles at a speed of 30 miles per second.

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PARTICULARS OF DOUBLY OBSERVED METEORS, 1897. *Contributed by* W. F. DENNING.

Date.	Time.	Mag.	Height at Beginning.	Height at Ending.	Length of Path.	Velocity (per second).	Began over	Ended over	Radiant.	Name of Meteor.	Observers.
1897.	h m		Miles.	Miles.	Miles.	Miles.			° °		
*April 22	10 25	2—2½	85	30	58	9	Cuckney, Notts. -	Caunton, Notts. -	161 + 59	β *Ursid*	D. B.; E. R. B.
„ 23	11 21	3—1	61	48	22	22	Hascombe - -	Bisley - -	213 − 3	*Virginid*	A. S. H.; W. F. D.
„ 23	11 37	3—1	62	53	15	21	Watlington - -	Denton - -	196 ± 0	*Virginid*	A. S. H.; W. F. D.
„ 30	9 38	5×♀	59	18	70	23	Cheltenham -	Banwell, Somerset -	291 + 59	o *Draconid*	W. F. D.; C. Grover and others.
May 5	12 31½	4—>1	68	48	35	20	Rochester - -	Braintree, Essex -	221 − 3	*Libríd*	W. F. D.; H. R. Maynard.
„ 5	12 49	4—2½	75	65	33	35	Woking - -	Reading - -	296 − 1	*Aquilid.*	A. S. H.; W. F. D.
†July 30	8 47	>♀	54	23	50	13	Poole, Hants. -	English Channel -	155 + 59	β *Ursid*	Seven observers.
Aug. 1	10 39	4	31	16	21	24	Swindon - -	Chippenham -	357 + 42	*Andromedid*	A. S. H.; W. F. D.
„ 1	12 14	2—1	55	42	25	Slowish	Dorking - -	London - -	296 − 6	*Aquilid*	A. S. H.; W. F. D.
¶ „ 2	10 46	3—2	44	40	7	Swift	Malmesbury -	S.S.E. Malmesbury	110 + 70	*Camelid*	H. C.; W. F. D.
„ 2	10 52	4—2½	59	55	44	15	Uxbridge - -	Brackley - -	339 − 24	*Aquarid*	A. S. H.; H. C.; W. F. D.
„ 2	11 5½	2	112	90	40	Swift	Basingstoke - -	Southampton - -	40 + 55	*Perseid*	H. C.; W. F. D.
„ 2	11 24	5—4	139	124	28	Swift	Berkhampstead -	Reading - -	73 + 66	*Camelid*	H. C.; W. F. D.
„ 3	13 40	2—1½	60	54	61	37	N.E. Margate -	Mouth of Thames -	72 + 11	o *Orionid*	A. S. H.: W. E. B.
„ 8	9 15	>♀	133	115	63	42	Clanfield, Hants. -	English Channel -	52 + 47	*Perseid*	A. S. H.; N. Lattey.

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PARTICULARS OF DOUBLY OBSERVED METEORS, 1897—*continued.*

Date.	Time.	Mag.	Height at Beginning.	Height at Ending.	Length of Path.	Velocity (per second).	Began over	Ended over	Radiant.	Name of Meteor.	Observers.
1897.	h m		Miles.	Miles.	Miles.	Miles.					
Aug. 9	13 27	3—1	140	77	81	100	Thrapston, Northampton.	Banbury, Oxon -	46 + 56	*Perseid*	A. S. H.; W. E. B.
„ 9	13 52	3—3	131	89	56	Swift	Wareham, Dorset -	12 miles S. W. of Portland Bill.	58 + 60	*Perseid*	A. S. H.; W. E. B.
„ 9	14 18	3× ♀	137	75	75	Swift	English Channel -	English Channel -	44 + 45	*Perseid*	A. S. H.; W. E. B.
„ 11	11 15	1—>1	79	57	37	Swift	Reading - -	Stockbridge, Hants.	47 + 55	*Perseid*	W. F. D.; J. A. H.
¶Sept. 26	11 50	4	41	35	6½	Slow	Wallingford -	New Wallingford -	36 + 43	*θ Perseid*	A. S. H.; J. A. H.
‡Oct. 22	6 23	>♀	59	35	171	Slow	Wooler, Northumberland.	North Sea - -	218 + 10	*Boötid*	T. R. Clapham and others.
Nov. 13	15 28	1	125	77	75	Swift	44 miles E. of Harwich.	Halesworth -	136 + 9	*Cancrid*	J. C. W. H.; W. E. B.
„ 13	15 52	1	103	59	60	Swift	Strait of Dover -	Cranbrook, Kent -	152 + 22	*Leonid*	W. J. H.; W. E. B,
Dec. 9	9 47	>♀	76	21	90	Slow	Aldeburgh E. Coast	Roydon, Herts. -	113 + 32	*Geminid*	E. H. Cullum and others.
„ 12	8 6	>♀	112	19	151	30	North Sea - -	Thirsk, Yorks. -	80 + 23	*ζ Taurid*	E. H. Cullum and others.

* The radiant is very doubtful, and may be further west, in the direction of Perseus.
† The heights and adopted radiant are somewhat uncertain.
‡ The observations are somewhat conflicting, and the path derived from them only approximately correct.
¶ These meteors are remarkable for their extremely short, visible paths.
N.B.—The unusual height of several of the meteors will be noticed

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SECTION FOR THE OBSERVATION OF THE SUN.

DIRECTOR.—MISS E. BROWN, F.R.MET.SOC.

SEVENTH REPORT OF THE SECTION, 1897.

Introduction.

This report, the seventh issued since the commencement of our Association, will be found to correspond in arrangement with those of the two previous ones, both as to the Calendar and Ledger. With regard to the latter, it may be well to mention that faculæ are recorded only when conspicuous, special attention being given to those appearing without any spots, and also when preceding or following them. It is needless to say that they are always present in spot groups, a fact which has been proved by the wonderful photographs taken by Prof. Hale, at Chicago.

An interesting article, by the Rev. Arthur East, elucidating this subject, appeared in the August number of "Knowledge" (1898).

The total number of groups recorded in 1897 amounts to 130 as against 161 in 1896.* On 21 days no spots were visible. During the previous year on only 3. The blank days on which no record was obtainable are, however, in excess, being 31 instead of only 19 as in 1896.

In referring to the accompanying illustrations, the Director regrets being unable to reproduce any of the photographs contributed, many being either on too small a scale or not sufficiently clear.

The examples chosen require a brief explanation.

Plate I. is from a drawing by M. Antoniadi of the large January group, of which two, by Prof. Pereira, have already appeared in

* NOTE.—Or, including sundry very small groups, formerly omitted in the reckoning, but appearing in the Ledger, 148 in 1897, as against 179 in 1896.

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the "Journal" (Vol. VII., p. 204), and one on January 31, from a sketch by Mr. Corder, taken when the same spot returned after rotation (Group 19).

Plate II. shows Group 20, a typical normal spot, on February 17, when one day W. of the central meridian; also Group 23 in which a singular detachment of a portion of the penumbra took place, and Group 30 in which a train of small spots, instead of following the leader equatorially, as is generally the case, were found streaming first to the S., and finally preceding it in a westerly direction.

Plate III. exhibits the striking changes which took place in Group 55 in the course of a few hours, the nucleus being curiously subdivided, a peculiar feature which occurred again in Group 89 (September 9).

Plate IV. is devoted to Group 77, one of the largest outbursts during the year. The "black holes" are conspicuous in the drawings by Prof. Pereira on August 5 and 8.

Plate V. is a reproduction of drawings published in the "Journal" (Vol. VIII., No. 4), of the remarkable group in December last.

NAMES of MEMBERS who have sent regular contributions during the year.

Name.	Address.	Instrument.	——
BARTLETT, J.	Bramley	4-in. O.G.	Drawings (projection).
BROWN, Miss E.	Cirencester	3½-in. O.G.	Drawings, measurements of position.
CORDER, H.	Bridgwater	6½-in. Spec.	Drawings (projection).
ELD, The Rev. F. J.	Polstead Rectory.	8½-in. Spec.	Measurements of position.
HADDEN, DAVID E.	Alta, Iowa, U.S.A.	4-in. O.G.	Daily record.
PEREIRA, J. DE MORAES.	Azores	4½-in. O.G.	Drawings and measurements of position.
SMART, Dr. D.	London	10-in. Spec.	Photographs and measurements of position.
TOWNSEND, J. S.	Sevenoaks	4½-in. O.G.	Photographs and diagrams.
WAUGH, The Rev. W. R.	Portland	4½-in. O.G.	Drawings (direct vision).

E. BROWN,
Director of the Section.

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Calendar of Sun-spots and Faculæ.

JANUARY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	1, 2, 3, 4	E. 20° S. W. region of group 1.
2	2, 3, 4, 5	E. 4° to 10° S. and 17° to 22° S. W. 20° to 25° N., and near equator.
3	3, 4, 5, 6.	
4	3, 4, 5, 6.	
5	3, 4, 5, 6, 7.	
6	3, 4, 5, 6.	
7	3, 4, 5, 6.	
8	5, 6.	
9	5, 6.	
10	5, 6.	
11	5, 6.	
12	5, 6.	
13	5, 6, 8, 9	E. region of 8 and S. p. W. region of 6, and S. p. it.
14	5, 6, 8, 9.	
15	6, 8, 9, 10, 11	E. 9° to 30° S. W. 0° to 15° S.
16	8, 9, 10, 11.	
17	8, 9, 10, 11, 11A	E. numerous, 6° to 17° S.; 60° to 70° E. W. 5° to 12° S.
18	8, 9, 10	E. 10° N., faint; 6° to 14° from limb to nearly 50° E. of centre. W. 7° to 13° S.
19	8, 9, 10, 12.	
20	8, 9, 12	W. about 20° S.
21		
22	8, 9, 12	E. 13° N. 15° to 20° S. 13° N.
23	8, 9, 12, 13	E. faint, far from limb. 15° to 20° S.
24	8, 9, 12, 13, 14	E. 14° to 26° S. W. 14° to 29° S.
25	12, 15	E. 0° to 10° N. W. 2° to 20° N. 5° to 25° S.
26	12, 15, 15A	E. 0° to 12° N. 0° to 3° S. W. 0° to 13° N. 0° to 16° S.
27	15	E. 10° to 22° S.
28	15.	
29	15, 16, 17	E. 0° to 3° N. 0° to 23° S.
30		
31	15, 17, 18, 19.	

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FEBRUARY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1		
2	15, 17, 18, 19	W. 5°, and 15° N.
3	15, 17, 18, 19.	
4	15, 17, 18, 19	E. 5° to 15° S. W. 3° to 15° N.
5		
6	17, 17A, 18, 19.	
7	17, 17A, 18, 19.	
8		
9	19, 20.	
10	19, 20	E. 0° to 15° N. 15° to 30° S. W. 5° to 25° S.
11	19, 20, 21	E. 5° to 10° N. 15° to 30° S., fainter. W. 0° to 15° S.
12		
13		
14	20, 22.	
15	20	W. 20° S.
16		
17	20	W., about 15° S.?
18	20	W., p. group 20.
19		
20	20.	
21	20	E., near equator. W. 2° to 20° N. 15° to 32° S.
22	23	E. 5° to 53° N. W. 2° to 15° N.
23	23, 24	E. 0° to 24° N. 0° to 6° S. Position of group 25.
24		
25		
26	23, 24, 25, 26	E. 3° to 15° S.
27	23, 24, 25, 26 27	E. 0° to 7° N. 0° to 18° S.
28	23, 24, 25, 26, 27.	

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MARCH 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	23, 24, 25, 26, 27.	
2	23, 24, 25, 26, 27	E. 8° S. Few.
3	23, 24, 25, 26, 27	
4	23, 24, 25, 26, 27	W., round and N. of group 23.
5	23, 24, 25, 26, 27	W. 5° to 25° N.
6	23, 24, 25, 26, 27	W. region of 24 and 25.
7	25, 26, 27, 28	W. 0° to 12° N. and 0° to 13° S.
8	26, 27, 28, 29, 30	E. region of 29 and 30° W. 3° to 13° N.
9	26, 27, 29, 30, 31, 32	W. 0° to 19° N. 0° to 14° S.
10	26, 27, 29, 30, 31, 32, 33	E. 3° to 18° N. 10° to 30° S. W. 0° to 8° N. 0° to 14° S.
11	29, 30, 31.	
12	30, 31, 34	W. region of 31, about 3° to 8° N.
13	30, 31, 34	W. 0° to 7° N.
14	30, 34.	
15	30, 34	W. region of 34.
16	30, 34	W., same position.
17	30, 34	W. bright patch, same position.
18	30	W. p. group 30.
19	30	E. to the N., far from limb. W. extensive p. and N. f. 30.
20	30	W. region of group 30.
21	No spots	E. 3° to 7° and 10° to 15° N. 4° to 7° S. W. 7° to 15° N.
22	35	E. 12° to 16° N. S.E. region of 35.
23	35	N.E., same position as yesterday, S.E. N. of 35 and f. it.
24	35, 36	E. region of 36.
25	35, 36	E., a few, about 15° S.
26	35, 37	E. region of 37.
27	35, 37	E. 3° to 25° S.
28	35, 37, 38.	
29	35, 37, 38	E. 0° to 11° N. 0° to 3° S.
30	35, 37, 38	E. region of group 38.
31	35, 37, 38.	

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APRIL 1897.

Day.	Groups of Sun-spots.	Faculæ.
1		
2		
3		
4	37A, 38, 39, 40, 41.	
5	37A, 38, 40, 41	E. 0° to 10° N. 0° to 3° S.
6		
7	38, 39, 40, 41, 42, 43, 44.	
8	38, 40, 41, 42, 43, 44, 45, 46	W. 0° to 10° N.
9	40, 41, 43, 44, 45, 46	W. 0° to 15° S.
10	40, 41, 43 44, 45, 46, 47, 48, 49	W. region of group 43.
11	40, 41, 44, 45, 46, 47, 48, 49	W. 0° to 12° N. 0° to 5° S.
12		
13	40, 44, 45, 47, 48.	
14	44, 47, 48	N.E., W. region of 41.
15	44	W. around 44 and a stream N. f. it.
16	50.	
17		
18	50, 51	E. 5° N. and 15° to 20° N.
19		
20	51, 52.	
21	51, 52.	
22	No spots	A few near W. limb position of group 20?
23	No spots	E. a patch near W. limb.
24	52A, 52B, 53	E. far from limb.
25	53	Region of 53.
26	53.	
27	No spots	A few N.E. and a very few W.
28	No spots.	
29	54, 55	E. region of 55, and 6° S. 65° E.
30	54, 55, 56	

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MAY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	54, 55, 56	E. p. group 56, and f. 57.
2	55, 56, 57	E. f. 56 and 57.
3	55, 56, 57.	
4	55, 56, 57.	
5	55, 56, 75, 57A	E. with a very small spot at 5 p.m.
6	55, 56	S.E. near limb.
7	55, 56.	
8	55, 56.	
9	55, 56	W. f. group 55.
10	55, 56	W. well marked stream S. of 55.
11	55, 56	W. region of 55.
12	56.	
13	No spots.	
14	57B.	
15	No spots.	
16	No spots.	
17	No spots.	
18	No spots.	
19	58	E., two patches near limb (region of 58?).
20	58, 59.	
21	58, 59.	
22	58, 59	E. near limb, on a line with 59.
23	58, 59.	
24	58, 59.	
25		
26	58, 60	Region of 60.
27	60, 61	E. around and S. f, 60.
28	60, 61	W. conspicuous near limb, position of 59.
29	60, 61	E. f. group 61.
30	60, 61	Around 60 a complete ring, only 10° from central meridian.
31	60, 61.	

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JUNE 1897.

Day.	Groups of Sun-spots.	Faculæ.
1		
2	60, 61.	
3	60, 61	E., N. of equator.
4	60, 61.	
5	60, 61	W. 5° to 15° S.
6	60	A very bright patch to the N.W. S. f. group 60, and one N. of it.
7	61A	E. patches far from limb, a minute spot in them (Hadden).
8	No spots	E. limb.
10	No spots	E. limb.
11	No spots.	
12	62	E. 18° to 35° N.; 8° to 22° S., without spots.
13	62, 62A.	
14	62	
15	62, 62A	E. 0° to 13° S. W. region of 62.
16	62.	
17	No spots	E. limb (position of 63?) one patch.
18	No spots.	
19	No spots.	
20	62B, 63	E. around 62B, and p. 63.
21	62B, 63.	
22	62B, 63, 64	E. region of 63.
23	63, 64	E. S. f. 63.
24	63, 64.	
25	63.	
26	63.	
27	63	W., a bright patch, S.
28	63, 65.	
29	63, 65	E. conspicuous around 65.
30	63, 65	E. region of 65. W. far from limb to the S.

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JULY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	63, 65	E. conspicuous on a line with 65. W. around 63.
2	63, 65	E. same position as on the 1st.
3	63, 65, 66	E. region of 66, and S. p. far from limb. W. around 63 and 65.
4	65, 66	E. around and f. 66. W. limb, region of 63?
5	65, 66	E. limb f. 66. S.W.
6	65, 66, 67	E. region of 67.
7	65, 63, 67, 68	E. slight around 67.
8	65, 66, 67, 68	E. 3° to 18° S. W. around 65.
9	65, 66, 67, 68	W. numerous, region of 65.
10	66, 67, 68	E. 12° to 26° N. W. 7° to 16° S. Conspicuous around and S. f. 68.
11	66, 67	W. position of 68, conspicuous; some far from limb.
12	66, 67	W. around 66, and some round patches near limb.
13	66, 67, 69, 70, 71	Around 67; although near the central meridian.
14	66, 67, 69, 71	W. around 69, and S. f. 66 W.
15	67, 69, 70, 71	W. around 70, and f. 69.
16	67, 69, 70, 71	W. 0° to 10° N. 10° to 20° S., and around 67.
17	71	E. small. W. extensive, 0° to 10° N., 0° to 20° S., both near and far from limb.
18	71	W. very conspicuous 5° to 15° S.
19	71, 72	E. around 72 and W. 5° to 10° S.
20	72, 73.	
21	72, 73, 74	E. numerous around f. 74, region of 73. W. some distance from limb (a couple of minute dots S.W. of centre).
22	72, 73, 74	E. around 73 and 74. W. numerous, 3° to 7° S. Position of 71.
23	73, 74	W. limb.
24	73, 74	E. a little N.; a patch S.W.
25	73, 74	E.
26	73, 74.	
27	73, 74.	
	73, 74	E. and W. limbs, rather faint.
29	73, 74, 75.	
30	73, 74, 75	E. bright circular patches, 20° to 25° S. W. region of 73 and 74.
31	73, 74, 75, 76	E. around and S. of 76: also marked f. it at 6 p.m. W. f. 73 conspicuous, 7° to 20° S.

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AUGUST 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	74, 75, 76	E. 10° to 15° S., f. group 76.
2	76	E. around 76. 10° to 15° S. far from limb. A patch to the N.
3	76, 77	E. extensive, region of 77.
4	77	E. the same region. W. 7° to 14° N. Some distance from limb.
5	77, 78	E. 10° to 20° S.
6	77, 78	E. f. 78.
7	77, 78	N.E. a few patches near limb.
8	77, 78, 78A	N.E. several distinct patches. W. limb, around 78A.
9	77, 78, 78A, 79	E. 10° N. 10° S.
10	77, 78, 80	E. 17° to 26° N.
11	77, 78, 80	E. region of 80°, p. 77 faint.
12	77, 78, 78B, 81	W. a patch p. 77, half way between it and limb.
13	77, 78, 78B, 81	W. numerous surrounding 77.
14	77, 78, 78B, 81	E. 16° to 27° N. at 20° N., stretching out horizontally. W. 2° to 20° S.
15	78, 78B, 82.	
16	78, 78B, 82	E. 6° to 15° S. Some patches far from limb. W. 10° to 20° S.
17	82	E. around 82 and S. of it. A few patches at some distance p. W. close to limb, position of 78.
18	82	W. 5° to 10° S.
19	82.	
20	82.	
21	82	N.W. a few round patches.
22	82, 83	E. a small bright patch.
23	82, 83.	
24	82, 84	W. p. 82, slight.
25	82, 84.	
26	82, 84A, 85	W. region of 82.
27	82, 85	E. a few patches in a line with each other, far from limb. W. region of 82, and patches to the S.
28	85.	
29	86	E. numerous p. 86.
30	86	E. 0° to 16° S.W., branching, 15° to 25°S.
31	86, 87, 88	E. 0° to 2° N. and 12° N. 0° to 15° S.

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SEPTEMBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	86, 87, 88.	
2	86, 87, 88, 89	E. p. group 89 and f. 88.
3	86 87, 88, 89	E. 10° to 20° S.
4	86, 87, 88, 89	E. 15° to 19° S.; N. f. 89.
5	86. 87, 88, 89.	
6	86, 87, 88, 89, 90.	
7	86, 87, 88, 89, 90	S.E. near limb.
8	86, 87, 88, 89, 90, 90A.	
9	86, 87, 88, 89, 90	W. around groups 86 and 87.
10	86, 87, 88, 89, 90	W. 5° to 20° S.
11	86, 88, 89, 90	W. 5° to 20° S. and N. around 88.
12	88, 89, 90, 91	W. 0° to 17 N.; 10° to 30° S.
13	89, 91	E. 3° to 13° S. W. 10° to 15° N.; 8° to 20° S.
14	89, 92, 93	W. region of 89.
15	92, 94	E. 0° to 12° N.
16	94	E. 0° to 12° N.; 0° to 10° S.
17	94, 95	E. s.f. 94 and N.W.
18	94, 95	W. 0° to 12° S.
19	94, 94, 96.	
20	94, 95, 96, 96A, 97.	
21	94, 95, 97, 98, 99	E. 0° to 16° N.; 0° to 3° S.
22	97, 98, 99.	
23	97, 98, 99, 100, 101	E. f. group 99. S.W. position of 95?
24	97, 98, 99, 100, 101,	
25	97, 98, 99	E. 3° to 13° S.; W. 0° to 10 N.; 0° to 3° S.
26	97, 98, 99, 99A, 102	E. 4° to 15° S.
27	97, 98, 99, 102, 103	E. 8° to 20° S. and region of 103.
28	98, 99, 102, 102A.	
29	99, 102, 102A, 103, 104	
30	99, 102, 103, 104	E. region of 104, and 3° to 20° S. extending far from limb.

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OCTOBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	99, 102, 103, 104	E. about 10° to 20 S. W. region of 99.
2	102, 103, 104	E. 7° to 20° S. W. 0° to 15° N.
3	102, 103, 104.	
4	102, 103, 104, 104A	E on equator. W. N. of equator.
5	102, 103, 104, 104A, 105	E. around and f. 105. W. numerous half way between 102 and limb.
6	102, 103, 104, 105	E. same as on the 5th. W. near limb p. 102, and patches S. of it.
7	102, 103, 106	W. region of 102, One patch more S.
8	102, 103	W. scattered patches 20° or more S., far from limb.
9	No spots	E. small patch, about 22° S. W. 0° to 20° S. conspicuous.
10	107.	
11	107	E. 2° to 14° N. S.W. far from limb.
12	107	E. f. group 107. W., scattered, far from limb.
13	107, 108.	
14	108.	
15	No spots.	
16	109.	
17	109	W. at three different distances from limb, N.
18	109	E. patches 8° and 5° N. W. 14° N.
19	109	A few E. and W. not very near limb.
20	110, 111	E. around group 111.
21	110, 111.	
22	111.	
23	111?	E. near limb; also W.
24	111	Two small spots observed only by Mr. Hadden near centre of disk, and two more a little S. of 111.
25	111	E. patches, one very far from limb.
26	No spots	E. extensive,
27		
28	No spots	E. small bright "knot."
29	No spots	E. 12° to 14° S. W. 5° N.
30	No spots.	
31	No spots.	

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NOVEMBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	112.	
2	113, 114	E. around 114. W. position of 112.
3	114	E. region of 114 numerous.
4	114.	
5	114	(Dots near the small spot 114 observed by Mr. Hadden.)
6	114.	
7	114	None seen, although clear.
8		
9	No spots	W. limb, small.
10	No spots.	
11	No spots	E. prominent to the S.
12	115.	
13		
14	115.	
15	115	E. a patch near limb. W. 5° N. far from limb; 14° S.
16	No spots	E. small patch.
17	115	(Three small spots near centre. Hadden.)
18	116?	
19	116.	
20	116, 117	W. around 116 and f. it.
21		
22	118	E. near equator 13° and 17° S. W. 15° N.; 3° to 7° N. 13 S.
23	No spots	E. far from limb. W. a small patch.
24	No spots	E. close to limb.
25		
26	118A, 119?	(Faculæ and a small spot 119 close to E. limb—Hadden.)
27		
28		
29	119, 120, 120A	E. 10° to 12° S. around 120A. W. near limb, circular patch N.
30		

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DECEMBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	119, 120A	E. 0° to 4° S.; 15°? S.
2	119, 120A, 121?	E. one large patch, bright, 17° S. With trace of a spot group 121?
3	119, 120, 121.	
4		
5	119, 121, 133	E. region of 123.
6	119, 121, 122, 123, 123A, 124	E. region of 123, 124. W. around 119.
7	119, 121, 123, 124.	
8	119, 121, 123, 124, 125	E. region of 124.
9	121, 123, 124	E. f. 124. W. position of 119?
10		
11	121, 124, 124A.	
12	121, 124, 124A.	
13	124.	
14	124, 126.	
15	124, 126, 127	E. 10° N.? W. about 8° N.
16	124, 127.	
17	124, 127	W. region of 124, and more N.
18	124, 127	W, region of 124.
19	124, 127.	
20	127	W. region of 124.
21	127.	
22	127.	
23	127.	
24	127	E. extensive, 3° to 16° N.
25	No spots	E. same position? further from limb.
26	128.	
27		
28	128	E. region of 130; 8° N.
29	128, 129, 130	E. region of 130.
30		
31	121, 129, 130.	

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Sun-spot Report, 1897.

LEDGER.

Jan. GROUP 1. *Long.* 164°. *Lat.* 14° S.

1. A small spot close to W. limb at 11 a.m. (One of the f. spots of Group 160, December 1896.)

Jan. GROUP 2. *Long.* 96°. *Lat.* 19° S.

1-2. A few very small spots W. of the central meridian. On the 2nd one only.

Jan. GROUP 3. *Long.* 49°. *Lat.* 12° S.

1-7. A normal spot, major axis about 30″. At first with a few small followers; when not far from the central meridian, circular; when near W. limb no observations obtained. (Group 161 of December 1896.)

Jan. GROUP 4. *Long.* 22°. *Lat.* 6° S.

1-7. A small normal spot (observed December 29, 1896). Nucleus curving westward on the 3rd, major axis 25″. Two small spots on the 7th.

Jan. GROUP 5. *Long.* 350°. *Lat.* 8° S.

2-14. A penumbral spot with somewhat irregular nucleus; ear-shaped on the 6th. A few small outliers f. on the 7th, major axis 45″. It became normal on the 9th, and again ear-shaped on the 10th, split into two equal parts on the 13th, but single when last observed on the 14th.

Jan. GROUP 6. *Long.* 342° to 329°. *Lat.* 2° to 9° S.

3. A considerable spot near E. limb, with an unusual amount of penumbra confined to the f. side. When first seen nucleus not exceeding in area that of the p. spot. (Group 5.)

4. Increasing, but giving no idea of the area it afterwards attained; penumbra still confined to the f. side; many small nuclei.

5. A large oval nucleus p. "followed by a branching stream of penumbral matter with nuclei." Weather in England almost entirely overcast after the 3rd. Observed chiefly in the Azores.

6. Area now enormous. Mr. Maunder computes the length to be 15°, or 115,000 miles, the breadth 6°, or 47,000 miles. (*See* "Journal" Vol. VII., p. 205.) One principal nucleus, five-lobed, and surrounded with penumbra. A mass of smaller spots streaming eastward with sharp nuclei and fragmentary patches of penumbra.

7. Nucleus broadly three-lobed, prolonged at the eastern extremity; penumbra branching out above and below. The f. spots more confluent and connected, but curving to the N. (A reddish brown tint perceptible.)

8. Main spot more inclined to the equator, nucleus very large.

9. Nucleus becoming elongated, with a bridge perceptible and a remarkable promontory showing a curve of at least 90° "indicating a whirlpool with motions in the direction of watch hands." The f. spots diminishing. (Observations and illustration by M. Antoniadi.)

10. Nucleus rounded in front and fimbriated; a thin bridge across the denser part at 1.30, which had almost disappeared at 2. Outline very complicated, somewhat resembling a scorpion. Black holes visible at 1.45. The whole changing under the eye.

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Jan. GROUP 6—*continued.*

11. Nucleus of a dark uniform tint, except a portion on the northern edge near the centre which is much lighter. The surrounding penumbra breaking up, and outlines less defined. The penumbra of the f. spots lighter in tint and studded with dots.
12. Already much foreshortened, nucleus still expanded in front, but with a sharp ring-like excrescence to the N. penumbra more indented; outlying spots fewer at the rear, many penumbral patches to the S. interlacing each other.
13. The penumbral patches still more dissected.
14. Nucleus still large and dense, the sharp excrescence dissevered from it, also a portion to the E. appearing at right angles to the p. leaving a space void of penumbra.
15. Two distinct nuclei. At noon penumbra very narrow towards the limb.

Jan. GROUP 7. *Long.* . *Lat.* about 10° or 12° S.

5 A tiny pair not far from W. limb. (Prof. Pereira.)

Jan. GROUP 8. *Long.* 212°. *Lat.* 19° S.

13. An irregular spot near E. limb, with a smaller one to the S.
14. Penumbra branching to the N.; spot to the S. almost gone.
15. Several nuclei, spot to the S. larger.
16. The S. spot again reduced.
17. Very compound, penumbra drawn out to the N.
18. In outline resembling a quatre-foil, nuclei small, hardly more than dots to the S.
19. Three nuclei.
20. Three distinct nuclei, penumbra chiefly on the N. f. side.
22. Much reduced, no near outliers, two more distant f.
23. Very small and faint.
24. Near limb.

Jan. GROUP 9. *Long.* 206°. *Lat.* 8° S.

13. A nuclear spot very near E. limb at 12.45.
14. Curved, nucleus double.
15. Divided.
16. Dwindling.
17. Nebulous, a pair.
18. Again almost in contact at 11. Mr. Bartlett observed three nuclei at noon.
20. Little change.
22. Penumbra on the N. p. side.
23. Reduced to a small pair without penumbra.
24. One faint little spot.

Jan. GROUP 10. *Long.* 266°. *Lat.* 12° S.

15. A small faint spot near the central meridian.
16. A pair.
17. A wide pair.
18. A double pair.
19. A few minute spots.

Jan. GROUP 11. *Long.* 198°. *Lat.* 18° S.

15–17. A very small spot which showed but little increase.

Jan. GROUP 11A. *Long.* 173°. *Lat.* 15° S.

17. A small spot not very far from W. limb.

Jan. GROUP 12. *Long.* 201° to 193°. *Lat.* 6° to 8° N.

19. A few small spots a little E. of the central meridian.
20. Very irregular.
22. A stream less than usually inclined to the equator. Leader larger than the rest.

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Jan.
23. Leader 1′ of arc in major axis, the f. increased; another large spot apparently in course of formation.
24. The two large spots nearly equal in area, nuclei smaller. The intermediates almost gone.
25. Leader with penumbra on the f. side and one nucleus.
26. The f. spot near W. limb.

Jan. GROUP 13. *Long.* 186°. *Lat.* 7° N.
23–24. A few little spots in two sets, widely separated. On the 24th one spot only, the f. set gone.

Jan. GROUP 14. *Long.* 171° to 169°. *Lat.* 10° to 12° N.
24. Little spots in two sets, but hardly larger than dots.

GROUP 15. *Long.* 59°. *Lat.* 6° N.
Jan. 25–Feb. 4. A normal spot showing but little variation; major axis about 50″. Nucleus with four divisions on January 31, bridged in two places on February 2, afterwards entire; a few outliers on January 29. Details difficult to obtain on account of cloudy weather.

Jan. GROUP 15A. *Long.* 119°. *Lat.* 2° S.
26 A tiny spot near the central meridian (Prof. Pereira).

Jan. GROUP 16. *Long.* 86° to 83°. *Lat.* 18° N.
29. Two small spots near the central meridian.

Jan. GROUP 17. *Long.* 25°. *Lat.* 2° S.
29. A faint little spot at some distance from E. limb.
Feb.
1. A little stream.
2. The leading spot larger, normal. The f. spots about 8° more E.
3. The f. spots more inclined to the equator.
4. Major axis nearly 1′ of arc. Nucleus three-lobed. A penumbral spot closely f. The f. spots more numerous.
6. Nearly normal.
7. Nucleus indented to the N. The penumbral spot dispersed.

Feb. GROUP 17A. *Long.* 17°. *Lat.* 10° to 11° S.
6–7. A few little spots widely separated; one only with penumbra.

Jan. GROUP 18. *Long.* 40° to 35°. *Lat.* 13° N.
31. Four little spots, the p. with slight penumbra.
Feb.
2. A cluster; spots all small.
3. Much increase in area, especially in the first and last.
4. Two spots, major axis of each about 50″, nuclei very irregular.
6. The p. near W. limb, nucleus double, the f. reduced.
7. The p. very near limb at 10.30. The f. very small.

Jan. GROUP 19. *Long.* 347°. *Lat.* 4° to 6° S.
31. A large normal spot, nucleus bridged. A return of the large January group. Two smaller f. (*See* illustration.)
Feb.
2. Nucleus of main spot entire; two spots closely following nearly normal.
3. Nucleus pointed on the S. f. side and curiously bridged.
4. More serrated and elongated eastward, black holes observed but no bridge in nucleus.
6. Nearly circular, 30,000 miles in diameter, a trail of dots N., the two f. spots little changed.
7. Nucleus hooked to the eastward, more scattered outliers.
9. Nucleus cloven to the N. and S. (Mr. Wykes.)
10. Cloven only to the S., penumbra opening on the N. f. side with a small nucleus apparently detached.
11. Near limb, penumbra nearly equal on both sides; small nucleus still visible. Three spots to the S.

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Feb. GROUP 20. *Long.* 212°. *Lat.* 7 N.
9. A large spot very near E. limb at 10.
10 Both nucleus and penumbra cloven at the base.
11. Nucleus fimbriated at the base.
14. Major axis 45″, nucleus still cloven, a few small followers.
15. On the meridian, slightly elongated.
17. No longer cloven. (*See* illustration.)
18. Many little outliers.
20. Little change.
21. Near limb, reduced. (In position not very far from Group 12.)

Feb. GROUP 21. *Long.* 266°. *Lat.* 3° S.
11. A pair of dots N. and S. of each other on the central meridian.

Feb. GROUP 22. *Long.* 244°. *Lat.* 16° N.
14. A very small pair to the W. of the central meridian.

GROUP 23. *Long.* 46°. *Lat.* 12° N.
Feb. 22–Mar. 6. A penumbral spot with a double nucleus attaining 1′ of arc in major axis. It showed signs of division on the 26th, and a portion of the penumbra became detached (*see* illustration), on this and the following day. On March 1 this detachment closed up again, two or more small nuclei occupying the lately vacant space. The spot was much reduced when near the W. limb.

Feb. 23–Mar. 6. GROUP 24. *Long.* 35°. *Lat.* 1° S. Another normal spot, near E. limb on the 23rd, which showed little change. Major axis 45″ on March 1. Area nearly the same when near E. and W. limbs.

Feb. GROUP 25. *Long.* 29° to 20°. *Lat.* 2° to 6° S.
26. A scattered stream of small spots and dots.
27. Very faint, only a few visible.
28. No details.
Mar.
1. Rather more in number.
2. Many more, also to the N. and S., but little increase in area.
3. Great increase, the leading spots coalescing and forming one nearly equal to Group 24. Those at the rear also increasing; no intermediates.
4. Leader 45″ in major axis opening eastward, with small nuclei streaming from it. The rear spots decreasing, with dots towards the West.
5. Leader with divided nucleus; the rear spots in a little dense cluster.
6. Broken up on the f. side, the cluster become a single spot with two nuclei.
7. Close to W. limb at 6.12 p.m.

Feb. GROUP 26. *Long.* 347°. *Lat.* 7° S.
27–Mar. 10. A normal spot (the second return of the large January group). Nucleus curved when near limb, penumbra nearly equal on both sides. It showed little change, except some variation in the form of the nucleus, which was crenated on the 4th, bridged on the 6th, and slightly curved when near W. limb. It gradually decreased in area, the major axis being 55″ on the 2nd and 45″ on the 6th.

Feb. GROUP 27. *Long.* 352°. *Lat.* 3° N.
27–Mar. 10. Another normal spot, about half the area of 26; penumbra on the f. side when near E. limb. Nucleus divided on March 1, entire on the 3rd, subdivided on the 5th and 6th, with small nuclei, as it were, ejected eastward, still remaining on the 8th. A few small followers on the 4th, forming a stream. When near W. limb much reduced.

Mar. GROUP 28. *Long.* 295°. *Lat.* 3° S.
7–8. A few tiny spots near the central meridian.

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Mar. GROUP 29. *Long.* 307°. *Lat.* 5° N.
8–12. A small spot near E. limb, with slight penumbra, which rapidly declined; was last observed at 8.15 on the 12th, but an hour or two later had disappeared.

Mar. GROUP 30. *Long.* 216°. *Lat.* 3° to 5° N.
8. A penumbral spot very near E. limb at 10.30, in nearly the position of Group 20.
9. Little change.
10. Nucleus angular.
11. A portion of the nucleus detached.
12. Penumbra bulging round the detached portion.
13. Larger nucleus cloven at the base.
14. Pointed at the base.
15. A sudden outbreak of small spots to the S. in two compact streams.
16. Streams more dispersed, curving westward. (*See* Illustrations.)
17. Main spot, with two smaller ones closely following, one stream curving round at the W. extremity.
18. The f. spots more distant from the main one. Stream still more westward, and components separated.
19. Nearing limb, reduced. Stream fast disappearing.
20. Two spots only visible.

Mar. GROUP 31. *Long.* 306°. *Lat.* 5° N.
9–13. Two very small spots in the western hemisphere, the p. with double nucleus on the 10th, but afterwards dwindling.

Mar. GROUP 32. *Long.* 258°. *Lat.* 4° N.
9–10. Three little spots in a line, on the 10th one only.

Mar. GROUP 33. *Long.* 281°. *Lat.* 13° S.
10. A wide pair of very small spots.

Mar. GROUP 34. *Long.* 265° to 262°. *Lat.* 7° N.?
5–17. One or two very small faint spots; more in number on the 15th and 16th; at last one only. Not in the Greenwich record (4547), but probably seen on the 17th by E. B. more S.

Mar. GROUP 35. *Long.* 41°. *Lat.* 2° S.
22–31. A penumbral spot not far from E. limb on the 22nd, showing little change, but somewhat decreasing. A few small outliers appeared on and after the 26th. The major axis could hardly have exceeded 20″ on the 30th.

Mar. GROUP 36. *Long.* 43°. *Lat.* 11° to 13° N.
24–25. One or two little spots, afterwards a stream; no increase in area.

Mar. GROUP 37. *Long.* 341°. *Lat.* 13° S.
26–April 2. A small spot with slight penumbra very near E. limb on the 26th. In major axis it did not exceed 30″ or 35″. It showed little radical change; two outliers only were observed on the 29th. The penumbra had a singular oval-shaped opening to the S. on the 31st. (In the same longitude as the larger group of January, but more S.)

April GROUP 37A. *Long.* 326° to 322°. *Lat.* 13° to 15° S.
4–5. Three small spots, the p. with slight penumbra; a cluster on the 5th.

Mar. GROUP 38. *Long.* 319°. *Lat.* 3° N.
28–April 2. A small normal spot, nucleus divided on the 31st. Some outliers chiefly to the S. on the 7th. Major axis 35″. When nearing the W. limb somewhat reduced. (N.B.—Three very similar spots were visible at the same time.)

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April. GROUP 39. *Long.* 334°. *Lat.* 2° N.
4. A small spot with slight penumbra in the western hemisphere, probably one of those observed by Mr. Hadden on the 7th.

April. GROUP 40. *Long.* 261°. *Lat.* 3° S.
4–13. A normal spot, major axis about 30″. But little change took place; nucleus double on the 4th, irregular on the 8th, decreasing on the 13th.

April. GROUP 41. *Long.* 232°. *Lat.* 5° N.
4–11. A small penumbral spot not far from E. limb. on the 4th. Major axis hardly more than 25″. Nucleus forked on the 8th; one or two outliers. By the 10th broken up into small fragments.

Ap. GROUP 42. *Long.* 291°. *Lat.* 8° S.
7–8. Some small spots in two sets following each other. Few details were obtained, and no note of their first appearance.

Mar. GROUP 43. *Long.* 289°. *Lat.* 11° S.
31–April 10. A few little spots. In two sets on the 8th, more in number than those in Group 42. When near limb on the 10th faint, but more numerous.

April. GROUP 44. *Long.* 221°. *Lat.* 2° N.
7–15. A considerable spot, three days E. of the meridian. On the 7th inclined to the equator. Major axis 45″ on the 8th, with an extension of the penumbra eastward; a few dots N., f. Almost circular on the 10th, with a gap in the penumbra and a trail of dots, on the 11th normal, nucleus with a cleft to the N. on the 13th, curved on the 14th. Penumbra equal on both sides when near limb. Longitude 227° when near W. limb. Seen as one or two very small spots on April 4 and 5.—(Greenwich Record.)

Apr. GROUP 45. *Long.* 220°. *Lat.* 7° N.
8–13. A penumbral spot, probably appearing at an earlier date to the N. of Group 44, and also equatorially inclined. A portion detached from the extremity on the 8th, after which date it began to decrease, was broken up on the 10th, reduced to three small spots on the 11th, and to two, still smaller, on the 13th.

Apr. GROUP 46. *Long.* 213°. *Lat.* 5° S.
8–11. Some very small spots in two sets, chiefly composed of dots on the 11th.

Apr. GROUP 47. *Long.* 198°. *Lat.* 6° S.
10–14. A cluster of small spots, the p. at first with slight penumbra, in three sets on the 14th, forming a stream.

Apr. GROUP 48. *Long.* 185°. *Lat.* 4° S.
10–14. A pair of small spots; one only on the 14th.

Apr. GROUP 49. *Long.* 162°. *Lat.* 8° S.
10–11. Two or three very small spots, in a line with 48; on the 11th, one only.

Apr. GROUP 50. *Long.* 154°. *Lat.* 3° N.
16–18. A very small penumbral spot, a few dots f. rapidly disappearing.

Apr. GROUP 51. *Long.* 147°. *Lat.* 3° N.
18–21. A little stream, more vertical than is usually the case. Three of the spots larger on the 20th. The leader apparently severed.

Apr. GROUP 52. *Long.* 110° to 105°. *Lat.* 3° to 4° N.
20–21. Three little nebulous spots following each other, one dot on the 21st.

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Apr. GROUP 52A. *Long.* 68°. *Lat.* 9° S.
24. A dot (observed only by Prof. Pereira).

Apr. GROUP 52B. *Long.* 45°. *Lat.* 14° S.
24. Another dot (Prof. Pereira).

Apr. GROUP 53. *Long.* 320°. *Lat.* 5° N.
24–26. A very small spot, hardly visible on the 26th (nearly the position of 38).

Apr. 29–May 1. GROUP 54. *Long.* 339° to 334°. *Lat.* 7° N.
Two little spots W. of the central meridian, widely separated; after April 29, one only.

Apr. GROUP 55. *Long.* 260° to 255°. *Lat.* 8° to 12° S.
29. A medium spot with double nucleus, penumbra confined to the p. side.
30. No details.
May.
1. Tapering and dividing eastward, a few outliers f.
2. Great increase, nucleus with six divisions, sharp, and at different angles to each other, more outliers, forming a tail-like appendage.
3. Still larger, nuclei more numerous, coalescing and curving chain-like at 12.30. At 5.45 p.m. more confluent. (*See* illustration.)
4. Elongating, five nuclei, major axis nearly 2′ of arc. A curved stream of small spots at the rear.
5. Signs of division, the nucleus p. bulbous in form, with a black hole, the f. elongated, somewhat resembling the vertibræ of a fish, outliers less curved.
6. Separation commencing at the rear.
7. Three principal nuclei, the central one lighter in colour, divided at the extremity and curving round.
8. Less complicated.
9. Smaller, three nuclei. Gaping at the extremity but not elongated.
10. Nearing W. limb. The whole spot seems to be bulging above the surface of the sun (Pereira). A few little spots to the S., and a stream of faculæ.
11. Near limb much decreased. Observed in the a.m. by the Rev. F. J. Eld. Not seen at 6 p.m. by Mr. Hadden.

Apr. GROUP 56. *Long.* 234°. *Lat.* 3° N.
30–May 12. A spot seen as a fine line near E. limb at 6 p.m. by Mr. Hadden. in nearly the same position as Group 41. Penumbra curving westward until after May 4th. Nucleus bridged on the 3rd, quadrangular on the 5th, a small portion appearing as if detached on the 9th and 10th. Few outliers. Major axis about 40″. It decreased a little in area.

May. GROUP 57. *Long.* 233°. *Lat.* 6° S.
2–4. A spot with slight penumbra, at some distance from E. limb on the 2nd.

May GROUP 57B. *Long* 148°. *Lat.* 8° N.
14. A very small black spot.

May GROUP 58. *Long.* 5° to 1°. *Lat.* 2° N.
19–26. A few very small spots observed near E. limb, at 11 p.m., by Mr. Hadden. On the 22nd a close pair; they seem to have increased a little in number, when last observed as a stream.

May GROUP 59. *Long.* 23°. *Lat.* 1° S.
20-24. At first only dots, then a cluster, increasing in number on the 22nd and decreasing afterwards.

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May — GROUP 60. *Long.* 270°. *Lat.* 9° S.

26–June 6. A considerable spot. When near E. limb with penumbra nearly equal on both sides. For the most part normal throughout, major axis about 1′ of arc. Some outliers p. until June the 3rd. A black hole in the nucleus on May 27th. On the 30th, when only about 10° from the central meridian, the Rev. F. J. Eld observed it surrounded with a complete ring of faculæ, which appeared raised above it. Dr. Smart also observed a bright ring round the penumbra on the 27th. It was close to the W. limb at 6.5 p.m., and had vanished at 8 p.m. (Mr. Hadden, Iowa), on June the 6th. The penumbra was wider towards the limb on the 5th.

May — GROUP 61. *Long.* 238°. *Lat.* 16° S.

27-31. A spot with slight penumbra, near E. limb on the 27th. It showed a little increase; with two nuclei on the 30th, but was finally reduced to two dots.

June — GROUP 61A. *Long.* 103°. *Lat.* 22° N.

7. A black dot observed at 10.48 by Prof. Pereira.

June — GROUP 62. *Long.* 138° to 129°. *Lat.* 16° S.

12. At 9.13 a m. some small nuclear spots in two sets N. and S. of each other, the one to the S. a tiny stream composed of 10 little spots close together. At 6.45, more divided, and with a little penumbra, both sets being now very similar. (Not seen at 11 p.m., on the 11th by Mr. Hadden).

13. The relative positions altered, much increase in area, the largest spot p. very compound, and changing rapidly, many sputterings between it and the f. spot at 6.10 p.m.

14. Two principal spots, both irregular, with numerous small nuclei.

15. Nearing W. limb, the f. reduced.

16. One spot, near limb at 9.15.

June — GROUP 62A. *Long.* 25°. *Lat.* 14° S.

13–15. A pair of very small black spots which did not increase.

July — GROUP 62B. *Long.* 289°. *Lat.* 11° S.

20–22. A small spot preceding Group 63.

June. — GROUP 63. *Long.* 272°. *Lat.* 8° S.

20–July. 3. A penumbral spot preceded by two very small ones in the midst of faculæ on the 20th. (A return of Group 60.) Major axis 35″. Penumbra on the 22nd rather wider on the f. side. Little change had taken place in area when near W. limb. On July 3 very close to it at 4.30 p.m.

June. — GROUP 64. *Long.* 344° to 351°. *Lat.* 9° N.

22–24. A wide pair of faint spots; more widely separated on the 24th.

June. — GROUP 65. *Long.* 179°. *Lat.* 4° S.

28. A small penumbral spot near E. limb.

29. A cluster in the midst of bright faculæ.

30. Spots larger, especially the leader.

July.

1. The p. spots forming one larger than the rest, with many small nuclei.

2. Leader with a portion detached, the rest all small.

3. F. spots disappearing.

4. Nucleus quadrangular.

5. More normal, solitary. Major axis about 35″.

6. Severed centrally. A few outliers.

7. A perfect pair.

8. Division wider, no outliers.

9. Northerly portion decreasing.

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July. GROUP 66. *Long.* 116°. *Lat.* 10° S.

3–14. A few very insignificant spots on the 3rd and 4th, which coalesced on the 5th, forming one penumbral spot at least 30″ in major axis; afterwards normal; two nuclei on the 7th. When near the central meridian, circular, nucleus entire, gradually decreasing, and very small when near limb.

July. GROUP 67. *Long* 65°. *Lat.* 6° S.

6. A penumbral spot near E. limb at 4.20 p.m.
7. Nucleus divided. (The third single spot of much the same area visible at one time.)
8. Irregular, five nuclei.
9. Split in twain, each portion with only one nucleus.
10. The f. portion larger, not exceeding 30″.
11. Portions nearly equal and more widely separated; penumbra on opposite sides.
12. Near each other; three faint little spots at some distance f.
13. Again almost forming one spot; three nuclei.
14. The p. portion decreasing, nuclei splitting.
15. One spot, smaller.
16. Three dots in the midst of faculæ.

June. GROUP 68. *Long.* 156° to 159°. *Lat.* 12° S.

7–10. A small faint spot in the western hemisphere; on the 8th and 9th a stream, the leading spot only with slight penumbra; on the 10th one spot.

July. GROUP 69. *Long.* 99°. *Lat.* 11° S.

13–16. Another faint spot in the western hemisphere, increasing a little at 7.30 a.m. on the 14th, and more in number at 6 p.m. On the 15th, 30″ in major axis, with two nuclei.

July. GROUP 70. *Long.* 82°. *Lat.* 8° N.

13–16. A wide pair, not seen on the 14th either at 7.30 a.m. or 6 p.m., nor in Greenwich Record. On the 15th still very small and nearer each other. (Mr. Hadden also noticed their disappearance on the 14th.)

July. GROUP 71. *Long.* 8° to 4°. *Lat.* 6° S.

13–19. Another wide pair of small spots in the eastern hemisphere, first observed at 7.15 p.m. Two pairs on the 15th, more widely separated; a stream on the 16th, expanding in front on the 19th, again, a wide pair on the 18th.

July. GROUP 72. *Long.* 272°. *Lat.* 9° S.

19–22. At first a nebulous spot, on the 21st a little pair (a return of 63).

July. GROUP 73. *Long.* 258° to 259°. *Lat.* 3° to 6° S.

20. A penumbral spot near E. limb.
21. Three irregular spots, the largest about 30″ in major axis.
22. Two principal spots, with divided nuclei, increasing in area.
23. Penumbra now curved and segmented; outliers increasing.
24. Many small nuclei, still much subdivision.
25. Further increase. Both spots split lengthwise. Major axis of each 1′ of arc.
26. The p. closing up, a vacancy in the centre, with small nuclei round it. The f. opening eastward.
27. The p. consolidating, the f. fast decreasing.
28. The p. almost normal, the f. nearly gone.
29. Nucleus of p. with only one division. Almost solitary.
30. Shrinking, nucleus cloven to the S. at 4.45 p.m.
31. Penumbra equal on both sides, not far from limb at 6 p.m.

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July. GROUP 74. *Long.* 244°. *Lat.* 12° N.

21–Aug. 1. A penumbral spot with double nucleus when first observed, entire on the 22nd August, singularly cloven on the 23rd, and closing up on the 24th, then normal. One or two small outliers after the 30th, when it was decidedly on the wane; major axis hardly more than 40″.

July. GROUP 75. *Long.* 200° to 198°. *Lat.* 8° N.

29–Aug. 1. A cluster of dots only, not seen at 10.30, but observed by Mr. Hadden at 1.10 p.m., then a miniature stream. On August 1st a dot barely visible.

July. GROUP 76. *Long.* 120°. *Lat.* 9° S.

31–Aug. 3. A very small spot surrounded with faculæ not very far from E. limb. A pair on August 1st, a still smaller spot f. With slight penumbra on the 2nd. A compact little stream on the 3rd, with no f. spots.

Aug. GROUP 77. *Long.* 68°. *Lat.* 6° S.

3. A large spot with irregular nucleus and deeply fissured, near E. limb at 7.30 a.m. A few small spots f. (A return of Group 67.)
4. Penumbra nearly equal on both sides.
5. Following spots larger. (*See* illustrations.)
6. Nucleus less fissured but more fimbriated, f. spots in close connexion, with a great amount of penumbra.
7. Major axis 1′ 12″. Nucleus still more fimbriated, f. spots quite detached from the leader and altered in position.
8. A portion of the nucleus separated from the main, radiations in penumbra clearly visible, f. spots smaller, some new ones to the N.
9. Near the central meridian, penumbra expanding to the E., f. spots rapidly decreasing.
10. Major axis 1′ 20″, detached portion re-uniting.
11. Penumbral expansion shrinking, f. spots few and scattered.
12. Penumbra streaming southwards but unbroken at 7.45 a.m., at 6.20 p.m., a portion detached.
13. More normal.
14. Near limb, penumbra nearly equal on both sides. Area differing little from ingress.

Aug. GROUP 78. *Long.* 42°. *Lat.* 16° S.

5–16. A small spot near E. limb on the 5th. Penumbra after the 6th chiefly on the S. f. side. Normal on the 7th. Two small spots far in advance and widely separated on the 12th.

Aug. GROUP 78A.

8–9. Two dots surrounded by faculæ near W. limb. One only on the 9th (observed by Mr. Hadden).

Aug. GROUP 78B. *Long.* 37° to 40°. *Lat.* 8° S.

12–16. A few little spots s. f. Group 78. More in number on the 13th, some with slight penumbra. On the 14th a double stream, but when near W. limb only two spots were visible.

Aug. GROUP 79. *Long.* 82. *Lat.* 6 ° N.

9. Two little spots N. p. group 77. One with slight penumbra.

Aug. GROUP 80. *Long.* 337°. *Lat.* 20° N.

10-11. A very small spot at some distance from E. limb on the 11th.

Aug. GROUP 81. *Long.* 299°. *Lat.* 3° S.

12–14. Hardly more than a dot.

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Aug. GROUP 82. *Long.* 259°. *Lat.* 8° S.
15–27. A normal spot. (A return of group 73). Penumbra on the 17th a little wider on the f. side; major axis 30″ on the 18th at 11.50, on that date penumbra markedly transparent to the N. On the 20th nucleus quadrangular. After this a few small outliers were visible for a few days. When nearing W. limb it decreased rapidly.

Aug. GROUP 83. *Long.* 237° to 234°. *Lat.* 15° S.
22–23. About eight little spots close together, in two sets. On the 23rd only three widely separated, the two p. mere dots.

Aug. GROUP 84. *Long.* 221° to 219°. *Lat.* 8° N.
24–25. Another group of small spots in two sets; on the 25th at 5.40 a.m., one faint spot (observed by Mr. Hadden).

Aug. GROUP 84A. *Long.* °. *Lat.* ° S.
26. A wide pair of very small spots in the Western hemisphere.

Aug. GROUP 85. *Long.* 192° to 190°. *Lat.* 9° N.
26–28. A little pair not far from the central meridian. On the 28th much more widely separated.

Aug. 29–Sept. 11. GROUP 86. *Long.* 70°. *Lat.* 6° S.
A normal spot observed at 7·40 p.m. by Mr. Hadden as a mere line close to E. limb; penumbra nearly equal on both sides at both ingress and egress; nucleus at first somewhat irregular, afterwards normal, when on the central meridian, circular. A few small outliers which disappeared after September 2. (A return of Group 77.)

Aug. GROUP 87. *Long.* 83°. *Lat.* 4° S.
31. A dot p. 86.
Sept.
2. A few little spots widely separated.
3. Some new ones with dots N. f.
4. The p. almost gone, great increase in those to the N.
6. The p. quite gone. The others consisting chiefly of two normal spots forming (with 86), three at nearly equal distances.
7. The leading spot irregular, the f. tapering in front.
8. Both with divided nuclei.
9. Nearing limb; more normal.
10. The f. near limb almost obscured by faculæ.

Aug. GROUP 88. *Long.* 50°. *Lat.* 14° N.
31. A small penumbral spot near limb at 5 p.m.
Sept.
1. No penumbra E. or W.
2. A bridge, dazzlingly white, across the nucleus, now with three divisions.
3. Two nuclei and two small ones, as if ejected.
4. One nucleus, pear-shaped, sputterings to the S.
5. Nucleus divided, still elongated.
6. Still broken up at the extremity.
7. Major axis nearly 45″.
8. Breaking up on the N. f. side.
9. Decreasing, a sudden outburst of spots f. one penumbral.
10. Following spots smaller.
11. Still decreasing.
12. Near limb, no followers.

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Sept. GROUP 89. *Long.* 39° to 22°. *Lat.* 9° to 11° S.

2. Some small scattered spots near E. limb, three only with penumbra.
3. Small nuclear spots p. closely connected N. and S. of each other.
4. Immense increase (at 8 a.m.). Two large spots, the p. with nuclei arranged crosswise and surrounded with penumbra, a few sputterings between. The f. nearly normal.
5. The p. with large nucleus in front and two or three smaller; the f. more circular, a cloud of small spots between them.
6. "Full of wonderful detail, a curious rectangular bridge across the nucleus of the p. cyclonic motion in the S. p. side of it" (Prof. Pereira). The f. spot also curiously bridged.
7. At 9.30 a.m. the p. very complex, large nucleus still in front, smaller ones at the rear, about 6 p.m. a rent took place almost cutting these off from the main. A tail-like wavy train of very small spots succeeding. The f. spot more regular. Some proper motion seems to have taken place about this time.
8. Still more complex, the rent closing up, the small nuclei very sharp and numerous, the train gone; f. spot breaking up.
9. The p. more elongated. At 2.30 a wonderful mass of sharp pointed nuclei at right angles to each other, in half an hour these points had disappeared. The f. spot semicircular with a swarm of dots in front of it as if an explosion had taken place.
10. Nuclei consolidating, portions at the rear quite detached.
11. Much altered, evidently on the wane.
12. One principal nucleus p. the f. more reduced.
13. Near limb, about four spots only.
14. The f. spot only seen.

Sept. GROUP 90. *Long.* 28° to 16°. *Lat.* 6° to 8° S.

6. A few small spots f. Group 89, in a little stream.
7. More in number and increasing in area.
8. Several with penumbra. The most easterly distinct from the rest; a forward motion in longitude seems to have taken place here.
9. Two principal spots, major axis 30″ and 20″, with only scattered dots between.
10. Both more normal.
11. Nuclei in both broken up.
12. The f. spot almost gone.
13. Near limb. Hardly more than one spot.

Sept. GROUP 91. *Long.* 32°. *Lat.* 12° N.

12–13. One or two small spots, with another much further S.

Sept. GROUP 92. *Long.* 295°. *Lat.* 7° S.

14–15. A small nebulous spot not far E. of the central meridian, only glimpsed on the 15th.

Sept. GROUP 93. *Long.* 244°. *Lat.* 5° S.

14. A few little spots in two sets in the eastern hemisphere.

Sept. GROUP 94. *Long.* 218°. *Lat.* 10° N.

15–21. A small spot, normal when near E. limb, but more irregular on the 16th, afterwards again normal; nucleus divided on the 19th, but with hardly any penumbra; several spots on the 20th, and a new one to the S. on the 21st.

Sept. GROUP 95. *Long.* 241° to 237°. *Lat.* 16° S.

17–21. At first one small spot without penumbra, afterwards a few more, lastly two, more widely separated.

Sept. GROUP 96. *Long.* 285°. *Lat.* 11° S.

19–20. Two very small spots in the western hemisphere; on the 20th one.

Sept. GROUP 96A. *Long.* 295°. *Lat.* 11° S.

20. A very small spot not far from W. limb. Nearly in the same position as 92.

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Sept. GROUP 97. *Long.* 186° to 179°. *Lat.* 9° S.
20. A cluster with a leading penumbral spot. New since the 19th.
21. Leader in the form of a horse-shoe.
22. A train.
23. Leader normal, few spots f.
24. Nearly circular, the f. very faint.
25. Solitary.
26. Little change.
27. Nucleus double.

Sept. GROUP 98. *Long.* 143°. *Lat.* 12° N.
21–27. A small penumbral spot with one or two followers, nucleus double on the 22nd, and again on the 26th, otherwise showing little change. It disappeared before reaching the W. limb.

Sept. GROUP 99. *Long.* 147° to 141°. *Lat.* 5° N.
21. A small penumbral spot, area larger than 98.
22. A stream of smaller spots f.
23. Spots about five in number, with more or less penumbra.
24. More spots f., and spreading to the N. and S.
25. Still more dispersed.
26. Again more stream-like.
27. The f. spots all very faint.
28. Leader only a small spot, the f. nearly gone.
29. Only a dot f.
30. Solitary, normal.

Sept. GROUP 100. *Long.* 203° to 200°. *Lat.* 7° N.
23–24. Two or three little spots in the western hemisphere.

Sept. GROUP 101. *Long.* 214°. *Lat.* 8° to 10° N.
23–24. One or two very small spots preceding Group 100.

Sept. GROUP 102. *Long.* 72°. *Lat.* 6° S.
26–Oct. 8. A penumbral spot, major axis about 30″. Nucleus on October 2 divided by a narrow bright streak, re-united on the 3rd. (A second return of Group 77.) A few outliers s.f. on September 30.

Sept. GROUP 103. *Long.* 62°. *Lat.* 9° N.
27–Oct. 8. A penumbral spot attaining to 45″ in major axis. Nucleus bridged on September 30th, curving northwards and deeply indented on October 3, but normal after the 4th. A few small outliers on the 2nd only.

Sept. 30–Oct. 6. GROUP 104. *Long.* 37°. *Lat.* 14° N.
A small spot with slight penumbra, one or two smaller N. f. on September 30, and a few S. f. on October 4 and 5.

Oct. GROUP 104A. *Long.* 41°. *Lat.* 14° S.
4–5. A faint little spot near the central meridian, probably seen by Mr. Hadden as two small dots on October 1.

Oct. GROUP 105. *Long.* 328°. *Lat.* 1° S.
5–6. A small nebulous spot not very far from E. limb; on the 6th two.

Oct. GROUP 106. *Long.* 15°. *Lat.* 3° S.
7. A small dark spot preceded by a still smaller one.

Oct. GROUP 107. *Long.* 251° to 247°. *Lat.* 11° N.
10–13. At first two little spots; on the 12th rather more in number, but without any increase in area. On the 13th one only.

Oct. GROUP 108. *Long.* 233°. *Lat.* 10° N.
13–14. Two very small spots. On the 14th reduced to one.

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Oct. GROUP 109. *Long.* 210° to 205°. *Lat.* 9° to 10° N.
16–19. A stream of small spots, the last somewhat nebulous, more scattered on the 17th, few and faint on the 18th. Prof. Pereira observed a tiny spot on the 19th at 6.18 p.m.

Oct. GROUP 110. *Long.* 177°. *Lat.* 5° N.
20–21. Three little spots, one only observed at 5.58 p.m. in the Azores.

Oct. GROUP 111. *Long.* 135°. *Lat.* 6° N.
20–25. A few very small spots; reduced to one, barely visible on the 24th and 25th.

Nov. GROUP 112. *Long.* 83°. *Lat.* 7° S.
1. A nebulous spot in the western hemisphere.

Nov. GROUP 113. *Long.* 359° to 354°. *Lat.* 10° S.
2. A very wide pair of small faint spots.

Nov. GROUP 114. *Long.* 304°. *Lat.* 11° S.
2–7. A small nebulous spot showing no increase, a dot p. on the 7th.

Nov. GROUP 115. *Long.* 194°. *Lat.* 8° S.
12–17. A small spot with a trail of dots f. half-way between the centre of disk and S.E. limb. First observed on the 12th, by Mr. Hadden, in the position of faculæ seen on the 11th, and probably again on the 17th. It was barely visible on the 15th.

Nov. GROUP 116. *Long.* 212°? *Lat.* 4° N.
19–20. A small spot near W. limb. The Rev. F. J. Eld observed forked faculæ following it on the 20th.

Nov. GROUP 117. *Long.* 177°. *Lat.* 5° N.
20. A pair; small, but quite distinct, observed only by the Rev. F. J. Eld.

Nov. GROUP 118. *Long.* 166°? *Lat.* 5° N.
22. A pair of dots lying N. and S. of each other in the midst of faculæ, about 50° W. of the central meridian; owing to cloudy weather they could not be traced to the limb.

Nov. GROUP 118A. *Long.* 74°. *Lat.* 9° S.
26. A very faint spot not far from the central meridian, probably the same described by Prof. Pereira as a tiny pair, and by Mr. Hadden as a few very small spots.

Nov. GROUP 119. *Long.* 350° to 340°. *Lat.* 6° to 8° N.
29. A small spot with slight penumbra, two little pairs f.

Dec.
1. Many spots in a stream, without penumbra, curving to the N. at the extremity.
2. Some increase in area.
3. The f. spots in a semicircle.
5. Great increase, a leading spot, 1′ of arc in major axis, two smaller compound spots f.
6. Leader normal, one of the f. broken up.
7. Leader little altered, one of the f. broken up.
8. The f. only visible at 12.30.

Nov. GROUP 120. *Long.* 334°. *Lat.* 8° S.
29. A very small spot in the eastern hemisphere.

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Nov. 29–Dec. 2. GROUP 120A. *Long.* 314°. *Lat.* 10° S.
Another equally small spot.

Dec. GROUP 121. *Long.* 272° to 280°. *Lat.* 15° S.
3. A cluster of very small spots. (Seen only by Mr. Bartlett on this date).
5. Two considerable spots, both compound.
6. The p. divided, the f. more normal.
7. The f. decreasing.
8. The p. with penumbra only to the W.
9. The f. almost gone.
11. One spot, much reduced.
12. Very small, faculæ f.

Dec. GROUP 122. *Long.* 257°. *Lat.* 1° S.
6. Two tiny pairs.

Dec. GROUP 123. *Long.* 238°. *Lat.* 9° N.
5–9. A small spot same distance from E. limb, with a little penumbra on the 6th, afterwards decreasing rapidly. A pair on the 8th.

Dec. GROUP 124. *Long.* 211° to 194°. *Lat.* 7° to 12° N.
6. A large normal spot near E. limb.
7. Bridged, more penumbral spots f.
8. Leader with large elongated nucleus, three principal spots f., two of of them to the N. with penumbra on opposite sides, the third streaming southwards.
9. Leader with nucleus dividing to the W.; the f. spots disintegrated; many small nuclei.
11. Leader bridged in several places, major axis 1′, f. spots coalescing, and very compound, with penumbra extending to the S.W. in a wavy line. Many small outliers. Rapid changes taking place. (*See* illustration.)
12. The f. spots in the form of a Y., nuclei more serrated, some penumbral patches dissevered.
13. Leader with a portion at the rear almost separated, f. spots again altered in form and position, and expanding to the S.
14. More subdivided. A scattered stream of faint spots 10° to the E, in Lat. 6° N.
15. Nuclei again more amalgamated, faint spots hardly visible.
16. Four or five penumbral spots.
17. Some new small spots f. Faculæ very extensive.
18. Whole group more disconnected.
19. Leading spot vanished at 12.49. The f. close to the limb. Spot to the S. with penumbra on the p. side.

Dec. GROUP 124A. *Long.* 219°. *Lat.* 5° N.
11–12. A few very small spots, p. 124.

Dec. GROUP 125. *Long.* 302°. *Lat.* 14° N.
8. A pair of small spots, some distance apart.

Dec. GROUP 126. *Long.* 174°. *Lat.* 2° N.
14–15. A little pair S. f. 124. On the 15th a dot only.

Dec. GROUP 127. *Long.* 100°. *Lat.* 3° N.
15. A faint spot near E. limb.
16. Small.
19. Larger. Nucleus pointed on the f. side.
20. Slight penumbra.
21. Nucleus dividing.
22. Smaller, nucleus double.
23. Still decreasing.
24. Very small.

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Dec. GROUP 128. *Long.* 312°. *Lat.* 15° N.

26. A small penumbral spot near E. limb.
28. Normal, three f.
29. Little change.
31. Major axis 35″ a small nucleus detached from the chief one, f. spots very faint.

Dec. GROUP 129. *Long.* 8° to 10°. *Lat.* 9° S.

29–31. A cluster chiefly composed of dots. Three little spots on the 29th.

Dec. GROUP 130. *Long.* 269°. *Lat.* 7° N.

29–31. A small normal spot near E. limb, breaking up on the f. side on the 31st.

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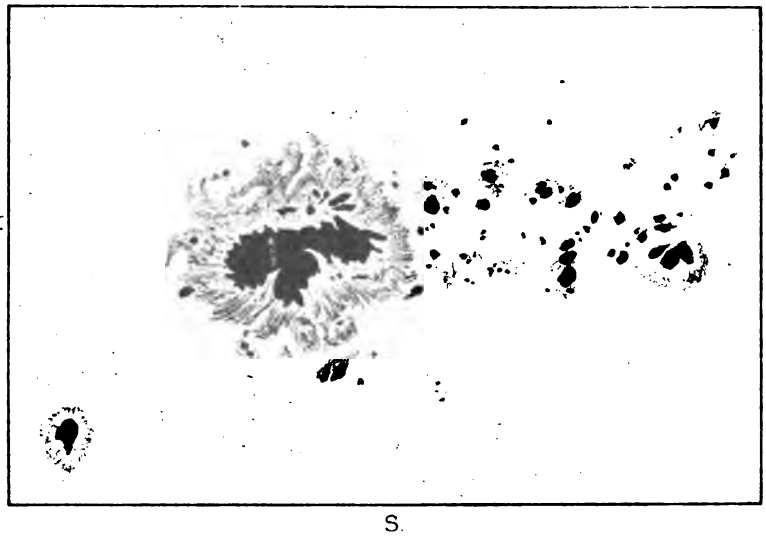
GROUP V. and VI. 1897.



The Great Sunspot of January 1897 drawn on the 9th at 1h 0m G.M.T.
E. M. Antoniadi del.

GROUP XIX. (Return.)

Jan. 31. 2 P.M. (Direct vision.) H. Corder del.

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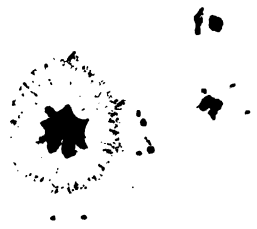
GROUP XX. 1897.



Feb.17.12. J.Wykes. del.

GROUP XXIII.

Feb.27.10.30. E.B.del

Mar.2.8.30. E.B.del

GROUP XXX.

Mar.15.12. E.B. del.

Mar.16.9.50 E.B.del

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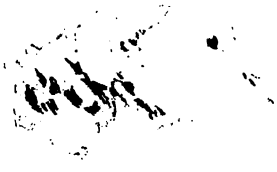
GROUP LV. 1897.

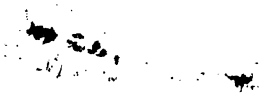
Apr. 29. 3.15. E.B. del.

May. 2 11.30. E.B. del.

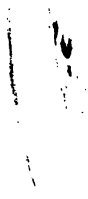


May. 3. 12.30. E.B. del

May 3 5h 45 E.B. del.



May. C. 9.15. J. Bartlett del.



W. limb.

May. 10 6.30 Prof. J. de M. Pereira. del.

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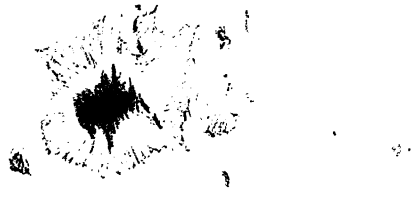
GROUP LXXVII. 1897.

E. limb.

Aug. 3. 9. 48. J. de M. Pereira. del.

Aug. 5. 9. 50. A. M. J. de M. Pereira.

Aug. 8. 11. 0. J. de M. Pereira. del.



Aug. 11. 3. 0 E. B. del.

W. limb.

Aug. 14. 5. 20. J. de M. Pereira. del.

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GROUP CXXIV. 1897.

Dec. 9. 10. 45.

Dec. 11. 11. 30.

Dec. 14. 12.

(By Projection. Sun's image 25^{in} diam.)

E. Brown del.

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SECTION FOR THE OBSERVATION

OF

THE MOON.

DIRECTOR.—WALTER GOODACRE, F.R.A.S.

FOURTH REPORT OF THE SECTION.

Introduction.

The lamented death of Mr. T. G. Elger, F.R.A.S., the former Director of this Section, has left a gap in the ranks of selenographers, which still remains to be filled. The present Director has endeavoured to pursue the lines he so ably laid down, simply adding to the same such new features as have been thought desirable. Amongst much excellent work that has been done by a restricted number of observers, mention must be made of the report on Ptolemaus by Mr. S. A. Saunder, M.A., F.R.A.S., of Wellington College. Micrometrical measurements of the positions of some of the objects on the floor of this interesting formation were made by Mr. W. H. Maw, F.R.A.S., and the results are given in the second report of the Lunar Section. Mr. Saunder's report, which is the result of two years work, shows that comparatively little now remains to be done. When he has completed his labours, results will have been attained which, from a selenographical point of view, will be as valuable as they are unique. The Director also wishes to express his indebtedness to those Members of the Section who have from time to time sent notes and sketches, and in particular to Capt. P. B. Molesworth, R.E., F.R.A.S., for the opportunity freely given to make use of his volumes of notes on lunar formations and the beautiful drawings accompanying them; several references to these occur in the following pages.

The time that has elapsed since the publication of the Third Report of the Lunar Section has not been wasted, as the present report will show, and whilst no remarkable discoveries (from the nature of the case) have been made, valuable progress has resulted in several directions, and points of doubt existing in relation to certain lunar objects have been cleared up. The detail shown in the illustrations and the descriptive matter given in this report, it is felt, cannot but be of great value to future cartographers of lunar surfaces.

Photography in connexion with the lunar surface continues to make progress, and some really excellent negatives have been secured by one of our Members, Mr. J. M. Offord, F.R.M.S., specimens of whose work have recently been brought before the

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Association. The Director would also like to call attention to the issue of Vol. I. of Herr Krieger's "Mond Atlas," the 28 beautiful maps which comprise the first volume are apparently based upon photographic enlargements, the minor details on which have been filled in at the telescope. They will repay careful study by all interested in selenography. The many admirers of the late Mr. T. G. Elger will note with pleasure that Herr Krieger seeks to perpetuate his memory by naming a formation after him—"Elger" is the imperfect ring-plain *f*, S.W. of Ramsden on Neison's map.

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Aristarchus and Herodotus.

Sketches have been received from Capt. Molesworth, dated 1892, November 1, and 1897, September 21, October 20, October 21; also a note on the Great Winding Valley, from Rev. T. H. Foulkes, M.A., dated 1897, October 22. The Director has also made sketches and notes, dated 1898, March 5 and 6.

In Capt. Molesworth's sketches of 1897, September 21 and October 21, the polygonal form of the inner walls of Aristarchus is well shown, and in the accompanying notes Capt. Molesworth records a very unusual appearance. The crater was at that time (September 21) just before sunset filled with shadow, and the inner terraces, which should have been invisible, were seen as faint knotted glimmering streaks under both E. and W. walls, and the central peak was also dimly discernible. Captain Molesworth suggests phosphorescence produced by long exposure to the sun's rays, or from inherent heat, or reflected glare from the western rampart, as possible explanations of this appearance. The interior and surroundings of Aristarchus seem to call for the most careful and constant observation; the Director has on more than one occasion seen what appears to be a faint bluish mist on the inner slope of the E. wall soon after sunrise, which was visible only for a short time. Capt. Molesworth has also seen the same appearance, which, he thinks, cannot be fancy or the result of contrast. Another curious feature exhibited by this crater, and which does not appear to be previously recorded was seen by the Director on 1896, March 6. At this time the floor of Aristarchus being free from shadow, several faint parallel dark streaks were seen crossing the floor and E. wall. Herr Krieger, in his beautiful map of Aristarchus and Herodotus, drawn 1897, April 14, depicts a similar appearance, except that he shows the streaks radiating from a centre instead of being parallel. The Rev. T. H. Foulkes has seen a dark streak crossing the southern part of Herodotus, which is possibly an extension of one from Aristarchus.

The Great Winding Valley, which is so closely associated with Aristarchus and Herodotus, has claimed a good deal of attention by some of the Members of the Section. It has always been a moot point among selenographers whether or not this valley terminates on the interior of Herodotus or outside its northern rampart. Neison and Elger held the former view, and Herr Krieger's map supports them. Prof. Pickering, as the result of his Arequipa observations, maintains the latter view. The Rev. T. H. Foulkes says, that from observations extending over a long time, there is no connexion between the gap on the N. wall of Herodotus and the S. end of the Winding Valley. The Director examined this object under favourable conditions in 1898, March 5 and 6, and the sketch then made (Plate 1.) fully bears out Mr. Foulkes' assertion. The Great Valley was seen to terminate abruptly in a distinct pear-shaped crater pit at about 10 miles from the N. wall of Herodotus, no extension of this valley beyond the crater was discernible, though carefully looked for. From this crater-pit the ground rises gradually, forming a rounded hill whose S. side slopes away to the N. wall of

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Herodotus; the hill is very dark in tint, very similar to the dark spots in Atlas; some little distance to the E. of the crater-pit, in which the Great Winding Valley terminates, is a short cleft, but quite apart and disconnected with the Great Valley; its proximity, however, may have caused some observers to have regarded it as a continuation of the Great Winding Valley, and to the conclusion that it debouched on the floor of Herodotus.

Atlas.

Considerable interest has been aroused in connexion with this fine ring-plain in consequence of the discovery of the variation in intensity of colour of the two well-known dark spots, situated one at the N. end and the other at the S. end of the interior. The variability of the S. spot was first noticed by Elger in 1870–1, and Prof. Pickering, as the result of observations at Arequipa in 1891, has confirmed this fact, whilst Mr. Stanley Williams's observations, made in 1883–7, have enabled him to deduce a light curve for both spots; the details of Mr. Williams' results have already appeared in the "Journal" (Vol. 8, No. 5). From each of these spots there appears to emanate a series of rills. Webb mentions having seen several rills, but gives no particulars. Neison refers to two, one seen by Webb, and the other by Gaudibert, these have often been seen since, and are not difficult objects under a suitable angle of illumination. Capt. Molesworth has submitted a fine sketch of Atlas (Plate I.), showing these two rills η and ϕ, and several others in addition, which are now published for the first time.

The small crater near the centre is probably the one discovered by Schroter, and seen since, but missed by Mädler; one distinct crater on the floor at the N. and three crater-pits near to it do not appear to have been recorded before. There is an enormous amount of fine detail on the floor of Atlas, which will amply repay careful examination with telescopes of large aperture.

Cassini.

A fine sketch of this crater, by Capt. Molesworth, has been received; it is dated 1892, Nov. 27, and is notable as showing more detail on the floor than recorded by either Neison or Elger. In the 3rd Report of the Lunar Section is a record of the observations of Herr Brenner, in which he states that he has found three small hills where two only have been seen before. Capt. Molesworth only shows two, he, however, shows one N. of the crater *b*, which may be one of the three referred to by Herr Brenner. Capt. Molesworth also shows Brenner's rill, between A and the W. wall, with several ridges near, also a small hill between this rill and the foot of the W. wall; he also shows a small crater N. of A, and close to or on the N. wall; this has not apparently been recorded before, but its existence is confirmed by Herr Krieger who shows it in the map of Cassini, which appears in Vol. 1 of

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his "Mond-Atlas." This map is based on an enlarged photograph of this formation, the finer detail apparently having been filled in as revealed by his 10½ Zölliger refractor. The close agreement between Capt. Molesworth's drawing and Herr Krieger's is remarkable, and completely testifies to Capt. Molesworth's accuracy and skill as a delineator of the lunar surface.

Cepheus.

This interesting formation has been sketched by Capt. Molesworth, and he shows in place of the small central elevation mentioned by Neison and Elger, a well-defined crater-pit, the sketch also shows a white spot on the N. side of the floor, a hollow at the foot of the S.W. wall, and a large ridge at the foot of the E. wall, with a horseshoe-like formation near the S.E. wall, giving the appearance of a ruined crater-ring. None of these objects are shown by Neison or Elger.

Cleomedes.

This is another formation which has been sketched by Capt. Molesworth, 1896, May 29, with the result of recording several features for the first time. His sketch shows a system of rills on the floor, mostly running from S. to N., terminating at the N. end in a cleft running from N.E. to S.W.; this latter is said to be an easy object, but the other rills are evidently fairly difficult to see except under specially favourable circumstances, as the Director, who has given considerable attention to the floor of Cleomedes, has, so far, failed to see any of them. Neison and Elger make no reference to any rills. Neison mentions that the E. wall contains several craters, but though this wall has been seen by the Director when close to the terminator several times no craters have been found. Neison also mentions a pass on the W. wall which has not been seen; there is one, however, in the S.W. wall which possibly may be the one in question; he also records three craters at the foot of the inner slope of the N. wall, but Schroter and Lohrmann only saw two, and this is all the Director has been able to see after the closest scrutiny under best conditions. It is much to be desired that Members with large apertures should give attention to these details so as to clear up the discrepancies now disclosed. At the N.E. end of Cleomedes the small ring-plain, Trailles, intrudes its S.W. wall into the interior of Cleomedes; at the foot of the S. wall of Trailles, and on the floor of Cleomedes, the Director has detected a crater-like object, when Cleomedes was on the evening terminator, and he noticed at the same time a cleft cutting through this S.W. wall of Trailles from the interior of Cleomedes, 1898, October 31.

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Craters between Reinhold and Landsberg.

In 1879, Birmingham discovered a small crater nearly midway between Reinhold and Landsberg, and a little to the S. of the ridge marked on Neison's map. This crater is not shown by Lohrman, Mädler, Schmidt, Neison, or Elger. The Members of the Section were asked to search for the missing crater on every opportunity. This search has resulted in its being found again, and also in the recording of several small craters and hills in the same neighbourhood whose positions, together with that of Birmingham's crater, have now been determined with fair accuracy. Birmingham's crater was found in the position he ascribed to it, and is a fairly easy object when the morning terminator is at W. wall of Landsberg, but its visibility is evanescent.

The sketch (Plate II.), was made by the Director 1898, April 30, at 10 hours. There are two minute hillocks close to the W. wall of Landsberg; the crater B just S. of the curved ridge is Birmingham's; within the horns of the ridge is a hillock, which might easily be mistaken for a crater cone, but has no depression on its peak; between the curved ridge and Reinhold are several small craters. These objects were first seen by the Director on 1898, March 2, and are also shown on a sketch received from Mr. R. Hodge, dated 1st April 1898.

Copernicus.

Mr. C. F. Smith sends a fine pencil drawing of Copernicus made 1898, March 2, 8^h to 10^h (Plate I.), which compares well with the drawing, given in Neison's "Moon," of this formation, but shows certain important differences in the detail it exhibits, the sketch also shows well the polygonal shape of the interior walls.

In an interesting observation made by Capt. Molesworth, dated 1896, May 5; he saw during moments of fine definition, a delicate rill running a short distance from the central mountain in a southerly direction, half-way towards the S. wall, when it suddenly turns to the E., and reaches the rampart; he also saw at the same time a small crater at the foot of the inner slope of W. wall. Neither of these two objects appears to have been recorded before.

Egede.

This small lozenge-shaped ring-plain, has received very little notice from selenographers, it is remarkable, not only for its peculiar shape, but for the lowness of its walls, which apparently do not exceed 400 feet in height in any part. They are, therefore, only visible when less than 15° to 20° from the terminator.

Capt. Molesworth sends a sketch, dated 1892, July 31, showing that the walls are broken down to the level of the plain on the E. side; also on the N. side, where, for a considerable distance only isolated hillocks and ridges remain; at the S. end is a broad pass or funnel-shaped opening to the surrounding plain, one crater-pit is shown on the S.W. wall, another close to a ridge

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inside the N. wall, and four smaller pits under inside of the W. wall. Several small craters are also depicted outside the walls on the N., S., and W. sides.

Herr Krieger, in his recently published Mond-Atlas, Vol. I., has a drawing of this formation which shows several important differences when compared with Capt. Molesworth's sketch.

Herr Krieger omits the four small crater-pits under the W. wall. He, however, shows a double crater-pit on the gap on the N. wall, where Molesworth only shows a small hillock. It is difficult to understand how Capt. Molesworth could have overlooked this twin crater if it is as prominent as Herr Krieger depicts it. On the S.W. wall, Capt. Molesworth draws a crater and a smaller one close to it, but on the floor, neither of which is on Herr Krieger's map, unless the double crater is intended for them. The positions on each map vary, however, to such an extent that this seems hardly possible.

Endymion.

Mädler and all later selenographers show the surface of this formation as being *quite smooth and free from detail of any kind*; only Schmidt records two low ridges of considerable length in the interior. The Members of the Section have had this object under observation for some time past, and the following interesting results have come to hand. Capt. Molesworth sends a sketch dated 1894, April 21, on which occasion he was fortunate enough to see the following detail on the floor.

Four craters almost in a line near the N. end of floor and running N. to S.

Three white hillocks under the E. wall, and at almost equal distances from each other. A small depression under the W. wall, and about half way between the N. and S. ends.

Seven white spots, and several longitudinal white ridges or markings connecting most of these spots, and apparently bearing the same relation to them as exists between the light streaks and spots on the floor of Plato. One of these spots, which he marks No. 5 on his sketch, he states to be the most prominent object on the floor. It is situated slightly S. of the centre and equally distant from the E. and W. walls.

Mr. R. Hodge, in an observation made 1898, October 31, records a distinct longitudinal ridge elevated at the ends, and apparently broken or discontinuous at the middle.

Mr. Donald Straker, also observing on the same date, reports seeing a streak running obliquely across the floor from N.W. to S.E., and two bright spots on its S. margin near the centre of the floor, also a fainter streak running from this oblique marking to the foot of the N. wall. It would appear that this streak is the same as shown by Capt. Molesworth, and on which his four crater-pits are situated.

It will be seen from the above that Endymion will amply repay the most careful and continuous study by those who possess telescopes of fairly large aperture. All the foregoing observations were made when Endymion was near the evening terminator.

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Gassendi.

Two very fine drawings of Gassendi by Capt. Molesworth have been received, they show many of the delicate rills which exist on the floor, some of which are exceptionally difficult objects to see, also a number of craters and mounds; a comparison of these drawings with the one figured in Neison's "Moon" reveal many points of agreement as well as of differences; a much longer study, and by more observers with telescopes of adequate power is requisite to do full justice to the multitudinous detail on the interior of this formation, which Elger justly describes as one of the most beautiful telescopic objects on the moon's surface.

Hesiodus.

We are again indebted to Capt. Molesworth for a beautiful drawing of this object made 1894, May 14. It shows that the large crater described by Neison as being on the outer slope of the N. wall is really at the foot of the *inner* slope; it also shows the well-known central crater missed by Mädler, which is very strange unless it has become more conspicuous since, and it further shows a small distinct crater to the W. of this, seen by Schmidt, but not referred to by Neison or Elger. Capt. Molesworth also depicts some hillocks close to the Wall at the E. end of the floor not recorded by any of the above mentioned authorities. This sketch also shows that Hesiodus A has a small previously unrecorded crater on its W. wall.

Linné.

This object was seen by the Director 1898, February 27, as a bright hillock casting a slight shadow, but without any crater-like depression on its summit, it was situated on a small greyish surface marking, which gave the impression of being a shallow saucer-like depression.

Macrobius.

The Director observing this crater on a recent occasion when the interior was nearly filled with shadow at sunset, the inner side of the west wall being very bright; there was seen a distinct penumbral fringe to the black shadow cast on it by the E. wall; it was best seen when using high powers.

The Director has also seen a similar light chocolate penumbral shade edging the black shadows on the W. wall of Humboldt, when on the evening terminator (1897, December 9); similar appearances have been seen at various times and by several observers. The explanation of this phenomenon is difficult; it almost suggests the existence of some kind of vapour in the interior of some of these craters; in any case, all such appearances should be carefully examined and recorded.

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Maclear.

A small though conspicuous ring-plain of about 16 miles in diameter. It has often been doubted if Maclear has a central hill. Schmidt, Lohrman, and Mädler show none. Neison only records a central greyish marking, there appears, however, now no question but that a low central hill does exist.

Miss Ashley, a well-known observer, has, according to the Selenographical Journal, seen a central hill on two occasions, 1879, October 4 and 5, and since then, in a note to the Director, she again mentions having seen it, 1881, December 10. The Rev. J. H. Foulkes, M.A., on 1897, November 2, saw a distinct hill with a blurred shadow on the *f.* side, and he is of opinion that the hill has a saucer-like depression on its summit.

Mr. W. J. Hall sends a fine sketch of this object, which is now reproduced (Plate II.), made 1898, September 5, showing the central hill and the curious shape of the surrounding walls as they are seen just before sunset; the light spot on S.E. wall is probable a peak.

Marius.

Beer and Mädler state that Marius possesses no central mountain, and they neither draw nor mention any other object on the floor, though they appear to have given considerable attention to it. Schroter, however, mentions a flat convex central elevation and also draws on S.W. wall a minute craterlet, which, Neison says, has not been seen since, and that probably Schroter was mistaken in thinking it existed. Unless some change has taken place in this formation since B. and M's. time, it does not appear that their examination of the floor could have been so critical as is suggested, seeing there is on the N.W. of the floor and close to the wall a very distinct craterlet discovered by Webb, and which is now a comparatively easy object. The low central hill has also been frequently seen since; Elger records the certain existence of four objects on the interior, (1) a crater on the N.W., (2) a white spot just S. of the centre; (3) a small spot just S.E. of this, (4) and another near the inner foot of the S.W. wall; all these objects, it is believed, have been confirmed. A sketch by Capt. Molesworth, dated 1896, August 21, shows eight objects on the floor. (Plate II.). No. 1 is the well-known crater on N.W floor. No. 2 is probably the missing crater of Schroter. This crater is also shown on a sketch by the Director (1887, December 6), and Mr. G. P. B. Hallowes shows it on a sketch, dated 1887, July 2 both these sketches also show an additional crater on the S.W. wall, a little to the S.E. of No. 2. The Director has also seen two other objects, probably craterlets, on the outside of the rampart, one N.E. and the other on the S.E.; the latter is shown, though not as a crater by Mr. W. H. Maw on a sketch, dated 1887, November 29.

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Mare Nectaris.

On an excellent photograph by Mr. J. M. Offord, taken when this object was near the evening terminator, some curious concentric ridges or faults are plainly shown apparently indicating the successive levels of matter originally liquid which forms the bed of this "sea." In connection with these ridges, the Director saw, 1897, December 28, a small circular depression in the centre of the Mare Nectaris, and roughly concentric with the above mentioned ridges; the depression forms the lowest part of the surface of the Mare, and may be the spot from which the supposed molten matter was ejected which has destroyed the seaward walls of so many of the ring-plains bordering on the Mare.

Messier and Messier A.

These craters have been objects of continued interest since Webb in 1855-56 called attention to the dissimilar appearance they then presented to the drawings and descriptions of Mädler. Since the Members of the Lunar Section commenced to give them special attention several interesting drawings have been received. These craters vary very much in appearance according to libration, and the angle of illumination at the time of observation; this variation, is well shown on two sketches, one by Capt. Molesworth, made 1892, July 28, showing the craters under morning light, and the other by Mr. E. A. Attkins, made 1898, September 3 before sunset. There are several delicate crater-pits near to A. which can only be seen with fairly powerful telescopes and fine definition. A further sketch from Mr. Attkins has been received, dated 1898, October 1, showing Messier and Messier A, near the terminator at sunset (*see* Plate 1). The sketch depicts on the interior of Messier, a rill or ridge running centrally across the floor from E. to W. This feature does not appear to have been previously noticed, except by Herr Krieger, who shows it in the map of this district in his Mond-Altas, Vol. I., drawn under a slightly lower angle of sunlight. In Messier A, Mr. Attkins depicts a very interesting feature, namely, a crescent-shaped ridge under the inner E. wall, which casts a narrow shadow. This ridge is probably a continuation of the spurs on the S.E. and S.W. walls mentioned by Elger as having been first seen by Schmidt. Capt. Molesworth's drawing shows these spurs, which are also shown in Mr. Maw's sketch in the last report of the Lunar Section (Plate V.). This inner ridge is shown by Mr. Attkins for the first time, as continuous in its entire length. In Herr Krieger's map, already referred to, spurs are shown projecting into the interior of Messier A from both the N. and S. walls, but they fail to meet in the centre. In Mr. Attkins' sketch are shown a number of crater-pits and white spots, these all appear on Herr Krieger's map, except *f*, *h*, and *j*. Herr Krieger shows *e* and *g* as craters; he also shows 1 as two small craters in contact, and another small crater close to the N.E. wall of 11. No crater-pits are shown within some distance of the W. wall of Messier, or to the N. and S., except *b*. The floor of Messier A was noticed to be darker than that of Messier. Mr. A. A. C. E. Merlin has seen 1, 2, and 3.

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Obscure and Partially Destroyed Ring-Plains.

All existing charts of the moon show very few of the traces of these more ancient features of the lunar surface, and scarcely any reference is made in the written description accompanying the same. It has been thought that some attempt should be made to record these interesting features, and the following details show what has been accomplished in a preliminary effort; large numbers exist in addition to those referred to in the plates, Nos. III. and IV. Some of these objects now depicted are well known, and form good examples of a much larger number whose existence is easily overlooked, and can, as a rule, only be seen for a very brief time when the terminator is close to them. In some cases all that remains of the original walls are a few isolated hillocks or mound-like ridges, probably under 500 feet in height; of this latter class Stadius is a well-known example; some of these formations are already designated by names, but others have been marked only with a letter for the purpose of rendering their identification more easy and certain, and this task is further simplified by the inclusion of some well-marked crater or ring-plain, which is usually associated with them; the dotted lines in each case show the position of the original ramparts, of which little now remains. It may be mentioned that the positions of these objects and their dimensions are only approximately correct:—

Plate III., Fig. 1. — Shows Le Monnier with its E. wall destroyed, probably by some action or force emanating from the M. Serenitatis. The most interesting member of this group is that lettered A, a remarkable ring-plain on the E. of Posidonius and slightly larger in size; whose walls S., S.E., and S.W., have been razed nearly to the level of the Mare, and the remains of which can only be seen with difficulty.

Fig. 2.—Shows four obscure formations to the S.E. of Ptolemaus. G is a partially destroyed formation shown on Neison's map and marked *c*. H is a larger and more irregular inclosure. J has much broken walls, and really forms a bay in H.

Fig. 3.—B and C. Two ring-plains, of the walls of which there remain only a few isolated hills.

Fig. 4.—Near Encke, and on the border of Oceanus Procellarum, are the remains of four obscure ring-plains, Encke itself being situated on the margin of the one marked D; of those marked G and F, the remaining walls are very low and only visible when near terminator.

Fig. 5.—Lubiniezky is shown by Neison and Elger to have walls intact, but they are broken down on the S.W. side, the round obscure ring-plain H is only well seen near terminator, I has a crater on the S. rim, which renders it easy of identification. Bonpland and Frau Mauro are too well known to need more than mention.

Fig. 6.—Shows some interesting objects of this class near Atlas and Hercules; J is not mentioned by Neison or Elger. M., seen

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with difficulty, is about the size as Hercules, and not mentioned by Neison or Elger. N probably shown by Neison.

Plate IV., Fig. 7.—Near Jansen are two incomplete ring-plains *a* and *b*, only *b* is slightly indicated on Neison's map.

Fig. 8.—S. of Maraldi are three obscure ring-plains, two of which, *a* and the one to the south, have incomplete walls.

Fig. 9.—Shows the well known inclosure E. of Burg. To the S. is a most interesting object, *e*, of whose original walls only a chain of hillocks exist on the W. side, and two crater cones on the E. side; there are also three hillocks in the centre, which are now all that remain of what was once a massive mountain.

Fig. 10.—Flamsteed stands on the south rim of a large ancient ring-plain whose walls are now represented by low ridges broken in many places, *j* and *k* are practically obliterated except in parts; *g*, *h*, *i*, *j* are not shown on Elger's map.

Fig. 11.—There are several obscure ring-plains N. of Ptolemaus, some only of which are shown on existing maps.

Fig. 12.—There are three very faint ruined formations N.E. of Frau Mauro. *v* has totally disappeared, except isolated peaks, which occupy the position of the original ring; *w* and *x* are very similar, except that *w* appears to have intruded on the floor of *v*; in the centre of *v* there are some low elevations, evidently all that now remains of what was once a large mountain.

Fig. 13.—W. of Bullialdus are some very imperfect rings, of which nothing remains but discontinuous portions of the original walls. One is a complete ring, but the walls are almost reduced to the level of the plain, and could easily be overlooked.

Fig. 14.—Is one of the most interesting of the series, and records an observation made by Mr. C. F. Smith, 1898, January 9th, and shows a number of oval light markings on the surface of Sinus Iridum, which gave a strong impression that they are the remains of once prominent ring-plains, whose walls have been overwhelmed by the matter which forms the present surface of this portion of the moon.

Posidonius.

This is a magnificent ring-plain in the N.W. Quadrant, and is interesting because of the inner ring concentric with the outer walls, and for the system of delicate rills found on its floor. On none of the maps extant are these rills shown in their entirety, and there still remains much work yet to be done in adequately figuring the wealth of detail on its surface. Drawings by Capt. Molesworth, Rev. A. Mackay, M.A., and the Director have been received. Capt. Molesworth's drawing dated 1894, September 10, is now reproduced (Plate II.). The well-known longitudinal rill is distinctly shown, also the cross rill at S. end of floor. At the foot of the cross-like figure, formed by the two above-mentioned rills, is a delicate rill extending nearly to the E. wall, which is only suggested in the drawing, it is shown more distinctly in another sketch by Capt. Molesworth of an earlier date.

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The Director's sketch also shows it, and Elger also records its existence, but Neison only its western half. There are many hillocks on the floor, and small craters shown by Capt. Molesworth, and mostly confirmed by Rev. A. Mackay, and which do not appear on the maps of Neison or Elger. From the central crater running N. to the inner wall, Rev. A. Mackay shows a delicate rill, which Capt. Molesworth confirms in his second sketch, who also shows another rill running from this crater in a S.E. direction and terminating at the inner wall just mentioned.

The well-known rill running E. to W. across the S. end of Posidonius is in reality a broad valley-like depression, and cuts through two considerable hillocks on its way, giving the appearance of a railway cutting; the interesting appearance noted by Schroter, who, on several occasions, found the central crater in Posidonius free from shadow, when it should have been full, and which was also seen to be the case by Gruithuisen (1821, April 7), has not been noticed by any Member of the Section. The various drawings to hand all showing a normal shadow in its interior.

Lunar Rills.

As yet no formal attempt has been made by Members of the Section to deal exhaustively with any of the various known systems of rills. A good number of sketches, however, have been received from Capt. Molesworth, who has given special attention to these objects, and they will form a most valuable basis upon which to work when observations by Members are seriously entered upon. Amongst the sketches to hand from Capt. Molesworth may be mentioned—

Rills near Guttemberg, 1892, May 1.
" " Cauchy, 1892, July 30.
" between Sabine and Plinius, 1892, July 30.
" near Ramsden, 1892, November 29.
" between Sabine and Silberschlag, 1892, August 14.
" N. of Menelaus, 1892, August 14.
" between Gassendi and Mersenius, 1892, September 3.
" near Plinius, 1891, February 14.
" near Triesnecker, 1892, April 14.
" between Ariadeus and Silberschlag, 1897, October 3.

In nearly every case the above sketches reveal additions to those mentioned in any of the existing maps. At present it would be inopportune to enter upon a discussion of these, a task which must be deferred till further observations accumulate, and the opportunity of giving the necessary illustrations presents itself. In the meantime the sketch of the Ariadeus system by Capt. Molesworth is reproduced in Plate II., and this will give a good idea of the excellence of the sketches which are catalogued above. In addition to the well-known features, a curious jointed appearance is seen in several parts.

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Torricelli.

Capt. Molesworth sends a drawing of this curious formation as seen 1897, October 1, showing the dual crater filled with shadow, also a curious ray from the N.E. wall as if there was a tunnel-like opening in the rampart through which the sunlight penetrated to the surrounding "mare." The sketch also shows a portion of the wall of a ruined ring-plain to the W. of Torricelli which was originally as large as Theophilus.

Micrometic Measures of Ptolemaus.

PRELIMINARY REPORT.

§ 1. *Method of Observation.*

These measures were commenced in 1896 in response to Mr. Elger's appeal, and have been continued on most clear nights when Ptolemaus has been near the terminator, and the moon at sufficient altitude. Progress has been slow, partly on account of irregularities in my driving clock, which were not overcome until the close of 1897, partly on account of want of experience, and partly on account of the inherent difficulties. Many of the objects on the floor are so difficult that they are seen only intermittently on the best nights, and so minute as to be completely hidden by the micrometer web. Many lunations also have been lost through clouds.

A few distances have been measured, but the usual method has been to measure the position angle of the line joining A and *d* at least three times, and usually again later in the evening; the mean of these measures being entered as the value at the mean of the times. The position angles of the lines joining A and *d* to other formations have then been measured, and corrected for change of tilt of the moon's axis, so as to reduce them all to the mean time for the measures of A *d*. This change of tilt may amount to as much as 15′ per hour when the moon's R.A. is near 6 hours or 18 hours; when near 0 hours or 12 hours the change is very slight. Under high illumination *d* becomes a comparatively difficult object, whilst 11 is usually distinctly seen as a bright spot; under these conditions the line joining 11 and H has been taken as the initial line, the angle this line makes with A *d* being approximately known, the angle made by any measured line with A *d* is at once determined. Measures from 11 have then been substituted for those from *d*. This has also been done in several cases where the lines from A and *d* were too nearly parallel to give a good determination. They have also, in a few cases, been combined with measures from A and *d* for purposes of control. Measures from the cone of Herschel have sometimes been similarly employed. Measures made in this way are inferior to those of position angle and distance from the same point, in that the angle of intersection is often far from a right angle, but they are more expeditiously made, and are far easier when either the driving or the atmosphere is unsteady.

When distances have been measured they have been corrected only for change in the moon's diameter by introduction of the

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factor $\frac{s}{s'}$, where $s = 15' 34''$, the moon's mean semidiameter, and s' is the apparent semidiameter at the time of observation, obtained from the "Nautical Almanac," and corrected for the moon's altitude. No correction has been applied for the conversion of conical into orthogonal projection; the principal effect of this would be to reduce the scale by about 0·4 per cent., a degree of accuracy to which I cannot hope to have attained; nor has any correction been made for differential refraction, the amount of which has never been sensible.

In consequence of the favourable position of Ptolemaus it was hoped that the corrections applied would give the positions with sufficient accuracy for the purpose of making a chart, as a complete reduction of each measure would have involved an amount of computation beyond anything I could have undertaken. It seemed desirable, however, to form some estimate of the possible errors introduced by the neglect of other corrections: an outline of the method adopted in this investigation, and the principal results, are given in the next Section of this Report.

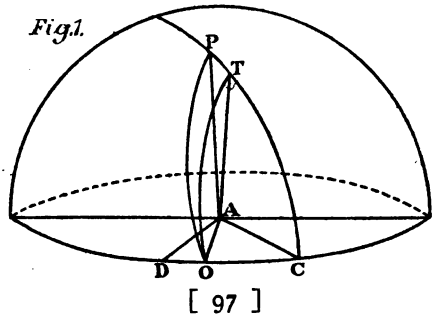
A more serious cause of error is to be found in the well-known difficulty experienced in bisecting a lunar formation of any size, and in the shifting of the apparent centre under varying illumination. To eliminate these errors observations should be taken under as many different angles of illumination as possible; most of my measures have been made under morning illumination.

My aim has been to measure each line at least three times on each of three nights, and I have usually endeavoured to observe the most difficult objects the definition permitted. If the measures have not been fairly accordant, more have been taken, but the group have not been allowed to count as more than three in the final means; if they have been badly discordant the whole have been rejected and easier objects tried. The measures are yet far from complete, and though I have divided the results so far obtained into two classes, yet of those observed on three nights, many have not been measured three times on each night. A series is often interrupted by failure of definition or the appearance of clouds.

§ 2. *Possible effects of Libration.*

In order to determine the possible errors introduced by neglecting the corrections due to libration it is necessary to connect the observed angles and distances with the true lunar bearings and arcs. This may be done as follows:—

Fig.1.



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Let A be the origin from which the measures are made,
P the formation whose azimuth and distance from A are required,
AT the tangent at A to the lunar great circle through A, P,
AO the line of sight,
AD the tangent to the lunar great circle through A, and the apparent centre of the moon's disk,
AC the production of the moon's radius through A, and therefore the common section of the planes PTA, ODA.

Let s' = the apparent semi-diameter of the moon,
s = " " mean " " "
ρ' = the distance of A from the apparent centre of the disk expressed in selenographical arc,
α = the angle PAT,
θ = " DOP,
γ = " OCP.

The line joining the observer to the apparent centre of the disk is in the plane COA and makes an angle $s' \sin \rho'$ with AO

Hence arc $OC = \rho' + s' \sin \rho'$

Also arc $CT = \frac{\pi}{2}$

$\therefore$ from the spherical triangle CPO

$$\cot \theta \sin \gamma = \tan \alpha \sin (\rho' + s' \sin \rho') + \cos (\rho' + s' \sin \rho') \cos \gamma.$$

For Ptolemaus A, $s' \sin \rho'$ is always less than 5′ and will be neglected.

$$\therefore \cot \theta = \tan \alpha \sin \rho' \operatorname{cosec} \gamma + \cos \rho' \cot \gamma$$

From this it follows that, if α be so small that $\tan^2 \alpha$ may be neglected, variations in θ and γ are connected by the equation

$$\frac{\delta \theta}{\delta \gamma} = \frac{\cos \rho'}{1 - x^2} - \frac{x \tan \alpha \, (\cos 2 \rho' + x^2)}{(1 - x^2)^2}$$

where $x = \cos \gamma \sin \rho'$.

In measuring the difference in bearing from A of two formations we measure the difference between the two values of θ, the true difference being that between corresponding values of γ. The above equation therefore gives the ratio between the true and measured values of a small angle. If α may be neglected altogether, this lies between $\cos \rho'$ and $\sec \rho'$. The greatest possible value of ρ', taking geocentric librations, is 17°·8. The values found during my observations range between 4°·4 and 15°·0. Taking the last value, the ratio lies between ·966 and 1·04, showing that the measure of a small angle may be wrong by 4 per cent.

It is, however, of more importance to discover the possible accumulation of error for a larger angle, that is the greatest value of $\theta \sim \gamma$.

To find this we put $\delta (\theta - \gamma) = 0$, or $\delta \theta = \delta \gamma$, which gives

$$(1 - x^2)^2 = (1 - x^2) \cos \rho' - x \tan \alpha \, (\cos 2 \rho' + x^2).$$

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This is a biquadratic, but if we examine the position of its roots we find that, since $\cos \rho' \neq 1$ and α is small, two of them are numerically greater than $\sin \rho'$, and therefore do not give real values of γ.

If $\alpha = 0$ the other two solutions are $x = \pm \sqrt{2} \sin \frac{\rho'}{2}$

When α is small the values of x will not differ much from these.

If we put $x = \pm \sqrt{2} \sin \frac{\rho'}{2} + \delta x$, and neglect terms of the second order in δx and α, we obtain finally,

$$\cos \gamma = \pm \frac{1}{\sqrt{2}} \sec \frac{\rho'}{2} + \frac{1}{2} \tan \alpha \, (2 \cos \rho' - 1) \operatorname{cosec} \rho'.$$

Few of the distances measured from A exceed 60 miles, which would give $\tan \alpha = \cdot 0277$.

If we now put $\rho' = 15°$, we find $\gamma = \pm 40°\cdot 2$ or $\pm 131°\cdot 6$
The corresponding values of θ are $\pm 40°\cdot 9$ or $\pm 130°\cdot 3$
The differences being $0°\cdot 7$ and $1°\cdot 3$.

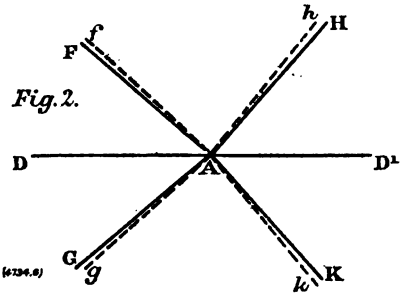

Fig. 2.

If A (Fig. 2) be the origin from which the measures are made, AD the direction of the apparent centre of the moon's disk which is measured in its true direction, then the line AF, which, on the lunar surface makes an angle $40°\cdot 2$ with AD, will be projected and measured in the direction A*f*, so that the angle DA*f* appears $0°\cdot 7$ larger than the true bearing DAF.

Similar remarks apply to the other lines in the figure, the angle DA*g* being also $0°\cdot 7$ larger than the angle DAG, and the angles D'A*h*, D'A*k* each $1°\cdot 3$ larger than the angles D'AH, D'AK.

The greatest error of excess will, therefore, be made in measuring the angle HAK which will appear $2°\cdot 6$ too large, whilst the angles FAH, GAK will appear $2°\cdot 0$ too small.

At mean libration when $\rho' = 8°\cdot 6$, the corresponding values of γ are $\pm 36°\cdot 9$ and $\pm 128°\cdot 2$, those of θ being $\pm 37°\cdot 0$ and $\pm 127°\cdot 7$, the differences being respectively $0°\cdot 1$ and $0°\cdot 5$.

The way in which these angles depend upon ρ' may be seen from the following table, which gives in the third column the

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greatest possible difference between the true and measured values of any angle; in the second column the angle for which this difference occurs; and in the first column the distance of the vertex from the apparent centre of the disk. The distances of the points H and K from A are throughout taken at 60 miles.

ρ'	HÂK.	hÂK—HÂK.
°	°	°
5	113·3	0·4
10	101·6	1·3
15	96·9	2·6
20	93·9	4·4
25	91·5	6·7
30	89·2	9·5
35	86·9	12·9
40	84·4	17·0

It must be remembered, however, that the angle which should be shown on a map is not usually the true lunar bearing, and hence the greatest "difference" here found is not the same thing as the greatest possible "error" of a measure, the term "error" being used to denote the difference between the angle as measured and as it should be drawn. Our object is to represent the appearance under mean libration. When ρ' is small the lunar azimuth of the apparent centre, that of the line AD (Fig. 2), may differ so much from that of the mean centre, that an angle which occupies the position HAK under mean libration, and should be represented in excess of its true value, may get nearly into the position KAG and so be seen too small, and *vice versâ*. As ρ' increases this possible change of azimuth decreases.

Thus in Ptolemaus, the angle HAK, in which the greatest "difference" occurs at mean libration, may, under other conditions be seen too small instead of too great. But the angle which occupies this position when ρ' has its greatest value, 17°·8, also appears too great at mean libration, though not to the same extent.

When, therefore, ρ' is small the possible "error" of a measure may exceed the "difference" given above; when ρ' is great, it can never be so large.

It must also be remembered that we are here considering the greatest possible error in a particular angle on the most unfavourable night. The errors in the means, caused by the neglect of the libration corrections, will be much less than these.

The variations in the apparent length of any line may also be determined from Fig. 1.

If D' be the distance of the moon's centre at the time of observation, Q' the measured length of AP.

The distance of A from the observer is—

$$D'\sqrt{1 - 2\sin s'\cos\rho' + \sin^2 s'},$$

$$\text{and } Q' = \frac{\text{AP sin OP}}{D'\sqrt{1 - 2\sin s'\cos\rho' + \sin^2 s'}}.$$

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If we denote the corresponding quantities at mean libration by omitting the accents, and ϕ be then the value of OP.

$$Q = Q' \frac{s}{s'} \sqrt{\frac{1 - 2 \sin s' \cos \rho' + \sin^2 s'}{1 - 2 \sin s \cos \rho + \sin^2 s}} \quad \frac{\sin \phi}{\sin OP}$$

The correction $\frac{s}{s'}$ has been applied.

The factor under the radical only affects the fourth place. We need, therefore, only consider the variations of $\frac{\sin \phi}{\sin OP}$.

The numerator depends only on the position of the formation whose distance from A is being measured; for different formations it may vary between 1 and cos $(\rho + \alpha)$.

The denominator depends partly on the position of the formation and partly upon the libration, it may vary between 1 and cos $(\rho' + \alpha)$.

Hence, on different nights and for different formations, the factor may vary between cos $(\rho + \alpha)$ and sec $(\rho' + \alpha)$.

If we again assume the distance of the formation from A to be 60 miles, and $\rho' = 15°$, the factor may vary between ·984 and 1·043, *i.e.*, some lines may be measured 2 per cent. too large, others 4 per cent. too small. It must again be remembered that these are the extreme values on the most unfavourable occasion.

It may be noted that a line for which $\sin \phi = 1$, that is a line at right angles to the line of sight at mean libration, can never be measured too long, and will usually be measured too short. Any other lines, and all angles, may appear either greater or smaller than under mean libration.

§ 3. *Reduction of the Measures.*

The first step is to determine the azimuth. For this, advantage was taken of the fact that the positions of Ptolemaus A and the cone of Herschel have been determined as points of the first order by Neison and Lohrmann respectively.

The sides of the triangle A, Herschel, *d*, were measured as follows:—

A − *d* = 28″·90	from	12	measures on	5 nights.
d − Herschel = 42″·15	„	8	„	2 „
Herschel − A = 49″·75	„	8	„	2 „

The computed angles of this triangle are, at Herschel, 35° 27′; at A, 57° 46′; at *d*, 86° 47′.

The angles were also measured directly as follows:—

At A, 57° 10′	from	12	measures on	4 nights.
d, 87° 11′	„	17	„	5 „

whence the deduced angle at Herschel is 35° 39′.

In the present imperfect state of the measures it would seem needless to adopt any more elaborate process than that of taking the means of these two sets of values. These give for the adopted values at Herschel, 35° 33′; at A, 57° 28′; at *d*, 86° 59′.

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The adoption of these necessitates some alteration in the lengths of the sides. To the nearest tenth of a second these may be 28″·9, 41″·9, 49″·6, or 29″·0, 42″·1, 49″·8. The principle of "least squares" gives decided preference to the latter set, which are accordingly adopted.

The positions given by Neison and Lohrmann show that the projection of the line joining A and Herschel should make an angle 21° 50′ with that of the principal meridian. This value is adopted. But these positions also show that the projected distance between the two points should be 51″·7, or 1″·9 greater than that found above. According to the usual method of determining points of the second order, this also should be adopted, and other distances altered to suit it. It is, however, so much greater than the value resulting from my direct measures, and this latter agrees within such much closer limits, not only with the lengths of the other sides of the triangle just considered, but also with the few other lengths that have been measured (as may be seen from the table of residuals given below), that for the present I retain my own value of the distance. The divergence will not, I think, seem excessive to those who are acquainted with the differences between the co-ordinates of the same points, when determined as points of the first order by different observers. It does not exceed Neison's estimate of the probable error in either co-ordinate of either point, and is, therefore, less than the probable error in the distance between the two. I have adopted the co-ordinates obtained from Neison's measures of Ptolemaus A in preference to those from Lohrmann's of the cone of Herschel, because the latter is such a large, irregular object, that I cannot feel certain that I have measured from the same point as that taken by Lohrmann. This same uncertainty affects both the adopted azimuth and the rejected length of the line joining the two points. I have endeavoured to measure from that point at which the shadow shows the highest peak to be situated, this is in the southern part of the area. Where it has been necessary to adopt co-ordinates for Herschel in the reductions, I have taken those resulting from my own measures as described above. I hope eventually to obtain positions of a few points by careful and fully reduced measures from Mösting A, which is very conveniently situated.

The position of 11 was next found, the measures of angle from A and *d*, and distance from A, being combined by least squares with weights proportional to the number of settings on which each depends, the length A*d* being taken as 29″·0. The residuals were not sensible.

Wherever other points have been determined by more than the necessary number of conditions, these have been combined by least squares, but without allowing variations of the relative positions of the four points A, *d*, 11, Herschel.

The degree of accuracy actually attained will be more profitably considered when the measures are further advanced. Some idea of what this is likely to be may perhaps be obtained from the following facts.

The most frequently measured angle was that between the lines A*d* and A1. This has been measured 24 (ranking as 21) times on eight nights, the values for the different nights being 105° 50′,

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104° 50′, 105° 35′, 104° 55′, 105° 25′, 105° 18′, 106° 16′, 105° 32′, the mean being 105° 23′.

The most frequently measured distance was A*d*, measured 12 times on five nights, as follows :—29″·1, 28″·6, 29″·1, 29″·0, 28″·6, mean 28″·9, and value adopted, as explained above, 29″·0.

The following table shows the residuals in cases where solutions have been effected by least squares, this residual representing the perpendicular distance of the final position from the observed lines :—

Quantity Measured.	Position Angle from A.		Position Angle from *d*.		Position Angle from H.		Position Angle from Herschel.		Distance from A.	
Formation.	Residual.	No. of Measures.	Residual.	No. of Measures.	Residual.	No. of Measures.	Residual.	No. of Measures.	Residual.	No. of Measures.
	″		″		″		″		″	
11	0·0	11	0·0	5	—	—	—	—	0·0	3
1	−0·1	21	+0·4	7	−0·3	6	—	—	—	—
19	+0·2	6	−0·1	6	+0·2	6	—	—	−0·1	3
20	−0·1	8	+0·3	8	−0·8	3	—	—	—	—
21	−0·1	9	—	—	—	—	−0·6	3	+0·4	2
25	+0·1	8	−0·3	3	—	—	—	—	+0·3	1
32	−0·1	9	+0·2	7	+0·7	1	—	—	—	—
36	−0·1	2	+0·1	3	+0·4	3	—	—	—	—
39	0·0	12	−0·2	4	+0·3	3	—	—	—	—
H	−0·1	12	−0·5	4	+0·6	9	—	—	0·0	9

With the exception of those for H, all the residuals which exceed 0″·4, belong to measures made on a single night, and the impression left on my mind from a study of the whole is that while such measures are liable to sensible error, the means of those made on several nights are sufficiently accurate for practical purposes, amongst which I would include the production of a map on a large scale, the computation of the state of illumination at any given time, and use in future discussions as to possible changes in the lunar surface.

In the following Table, the values of X and Y are given, as usual, in parts of the moon's radius; the axis of X is—as in Neison—the projection of the moon's equator, the axis of Y that of the first meridian :—

Selenographical Positions of Formations.

——	Longitude.	Latitude.	X.	Y.
	° ′ ″	° ′ ″		
Ptolemaus A, as determined by Neison.	−0 58 22	−8 54 58	−·01679	−·14924
Cone of Herschel, as determined by Lohrmann.	−2 9 7	−5 37 6	−·03737	−·09789
Cone of Herschel, position adopted	−2 7	−5 44	−·0366	−·0997

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Formations measured on three or more nights.

Formation.	Longitude.	Latitude.	X.	Y.
	° ′	° ′		
d	− 2 45	− 8 15	−·0473	−·1435
1	− 0 49	−10 38	−·0140	−·1844
4	− 0 5	−10 4	−·0015	−·1748
11	− 4 12	− 8 46	−·0724	−·1525
19	− 3 38	− 9 21	−·0625	−·1626
20	− 1 30	−10 14	−·0258	−·1777
22	− 1 12	− 6 42	−·0210	−·1169
25	− 2 47	−11 7	−·0476	−·1927
31	− 4 6	−10 36	−·0701	−·1838
32	− 3 34	− 9 45	−·0614	−·1692
39	− 1 2	− 8 59	−·0178	−·1561
G	− 0 5	− 7 38	−·0015	−·1329
G_1	0 0	− 7 16	+·0001	−·1264
H	+ 0 29	− 9 31	+·0082	−·1652
K	− 3 29	−11 18	−·0595	−·1961
M	+ 0 12	−10 41	+·0035	−·1854
N	− 0 14	−10 30	−·0040	−·1821
R	− 3 18	− 7 11	−·0570	−·1250
S	− 3 38	− 7 13	−·0628	−·1256
T	− 1 34	− 6 51	−·0273	−·1192
U	− 1 58	− 6 48	−·0340	−·1183
Herschel B	− 2 25	− 6 26	−·0418	−·1122

Formations measured on less than three nights.

Formation.	Longitude.	Latitude.	X.	Y.
	° ′	° ′		
2	− 0 53	−10 14	−·0152	−·1775
3	− 0 39	− 9 36	−·0112	−·1666
5	− 1 20	− 9 36	−·0230	−·1668
7	− 3 57	− 8 31	−·0681	−·1481
18	− 2 59	− 7 38	−·0516	−·1330
21	+ 0 33	− 8 7	+·0095	−·1412
23	− 2 0	−10 38	−·0344	−·1845
26	− 3 5	−10 53	−·0528	−·1889
28	− 3 11	−10 35	−·0545	−·1838
29	− 3 29	−10 51	−·0597	−·1881
33	− 3 29	−10 2	−·0597	−·1742
34	− 4 3	−10 19	−·0696	−·1791
35	− 4 10	−10 9	−·0716	−·1763
36	− 3 9	− 8 15	−·0545	−·1435
37	− 0 46	− 7 41	−·0131	−·1338
38	− 1 1	− 7 46	−·0175	−·1350
40	− 1 33	− 8 58	−·0267	−·1559
41	− 0 26	−10 17	−·0073	−·1785
42	− 0 33	−10 35	−·0094	−·1837
L	0 0	−11 10	·0000	−·1937
P	− 4 20	− 7 57	−·0749	−·1383
Q	− 4 48	− 8 8	−·0828	−·1415
η	+ 0 20	− 8 38	+·0059	−·1502
μ	− 2 49	− 7 2	−·0488	−·1224
ν	− 0 42	− 7 11	−·0122	−·1252

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Formation.	Longitude.	Latitude.	X.	Y.
	° ′	° ′		
a	− 0 49	− 8 1	−·0142	−·1395
e	− 1 58	−10 46	−·0337	−·1867
h	− 3 31	− 9 30	−·0606	−·1651
i	− 2 36	− 9 46	−·0446	−·1697
l	− 3 22	− 8 36	−·0582	−·1496
p	− 1 14	− 9 26	−·0212	−·1640
r	− 2 1	− 9 7	−·0348	−·1584
s	− 3 1	− 9 27	−·0519	−·1642
t	− 2 47	−10 26	−·0479	−·1812
u	− 2 35	−10 9	−·0443	−·1763

a, *e*, *h*, *i*, *l*, *p*, *r*, *s*, *t*, *u*, denote the approximate positions of the centres of these saucer-shaped depressions; they are, from their nature, subject to larger errors than the other objects in the list.

s is very shallow, smaller than *h*, and to the west of it.

Of the other formations in this list not shown in Mr. Elger's last map (Memoirs, Vol. iii., Pt. 5, Plate I), those on the walls, denoted by capital letters, are all conspicuous. K, L, R, S are circular craters of the same type as H; M, N, P, Q, T, U are larger and more nearly resemble 21, 22. Those on the floor are small. 32 is on the S.E. border of *h*, 33 is on the E. end of a conspicuous bright patch; 34, 35 are two small craters N. of 31; 36, another small crater, E. of *d*; 37, 38 are on the rim of *a*, and are clearly shown in one of the Lick photographs; 39, 40, 41, 42 I have seen only under fairly high illumination, when they appear as small well defined bright spots, their appearance being similar to that of other small craters on the floor under similar conditions.

Mr. Elger (Memoirs, Vol. III., Pt. 5, p. 157) describes 5 as "a conspicuous crater." I have never been able to see it as a crater, but there is a brighter patch on the bright streak running southwards from A in about the position indicated. It is the position of this bright patch that I have measured. On the next page Mr. Elger describes two craters at 31, 30. I am able to confirm Mr. Maw's observation (Memoirs, Vol. ii, Pt. 2, p. 31) that under suitable illumination three confluent craters may be seen here, of which 31 is the most northerly.

On plotting the positions given above it seemed probable that 23 is associated with *e* in the same way that 37, 38 are with *a*, or 19, 32 with *h*, but I have not obtained direct evidence of this. *v* is the high mountain mass on the N. wall, a little west of the line joining A—22.

S. A. SAUNDER.

P.S.—It will be evident from what has been said above, that if any approach to accuracy is desired it will not be possible to neglect the libration corrections when mapping formations much further from the mean centre of the disk than Ptolemaus. Since the report was written, however, Prof. H. H. Turner, F.R.S., has very kindly suggested a method of applying these corrections by which a considerable saving is effected in the computation required, with no loss of accuracy. I have already taken some measures

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for formations nearer the limb, and hope I may be allowed to return to the point when I have acquired more familiarity with the work.

S. A. S.

The map has been constructed as follows:—The measured points were first laid down on squared paper on the scale of 200 inches to the moon's diameter. The contour of the foot of the walls was drawn at the telescope between 8^h and 10^h on 1898, November 22, and the positions of five or six points on it determined with the micrometer. These points were laid down on the squared paper and the contour drawn in after comparison with two photographs—Paris Observatory Atlas, Plate III., under morning illumination, and Lick Observatory Atlas, Plate IV., under evening illumination—which were kindly lent me by Prof. Turner. I hope that in this way substantial accuracy has been secured. The other formations were drawn in chiefly from Mr. Elger's map in the Third Report of the Lunar Section, "Memoirs," Vol. III., Part 5, supplemented by a few notes of my own. Traces were found of *b*, *c*, and the two low ridges from A to *p* and *r* on the Lick photograph, as also of the light spot about 33 and of the dark patch in the N.E. corner. The contour of this last was drawn on November 22, and extends further than that shown by Mr. Elger. The two bright streaks intersecting at 20 were drawn at the same time.

The drawing having been completed on the squared paper, a tracing was made, which has been reduced by photography to one-fourth the original size. In the preparation of this tracing I have received very great assistance from Mr. H. W. Owen Hagreen, to whom I am much indebted.

In order to facilitate use at the telescope the designations of those objects whose positions have been measured have been underlined. It is very desirable that the positions of other objects should be determined by cross alignments from these.

S. A. S.

The Director would like to emphasise the closing remark by Mr. Saunder as given above, the positions of so many objects have now been determined that with the aid of the chart identification should be a comparatively easy matter, and by the method of alignment new objects can be inserted with close approximation to accuracy—more objects could have been inserted in the map, but it has been thought well not to risk overcrowding it. Four have, however, been inserted on the authority of Herr Krieger's map; a rill β under the W. wall and a small crater on its eastern side No. 8, also a corresponding rill on E. side δ, and a small crater, No. 6, between it and E. wall; this latter has been seen by the Director, and also the rill δ in part, 1893, March 25. Much valuable help has been given by the Rev. A. Mackay, M.A., in confirming many of the craters in the chart, and in locating others whose exact positions have yet to be determined.*

W. G.

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* Two errors occur in the lettering of the map. *For* "C" *read* "*c*"; and *for* "V" *read* "*v*."

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FIG. 1. ARISTARCHUS AND HERODOTUS.
(1898, March 5, 9 h. to 10 h.)
By W. Goodacre, F.R.A.S.

FIG. 2. MESSIER AND REGION.
(1898, October 1, 10 h. to 11 h. 25 min.)
By Ernest Attkins.

FIG. 3. ATLAS.
(1892, August 10)
By Capt. Molesworth, F.R.A.S.

FIG. 4. COPERNICUS.
(1898, March 2, 8 h. to 10 h.)
By C. F. Smith.

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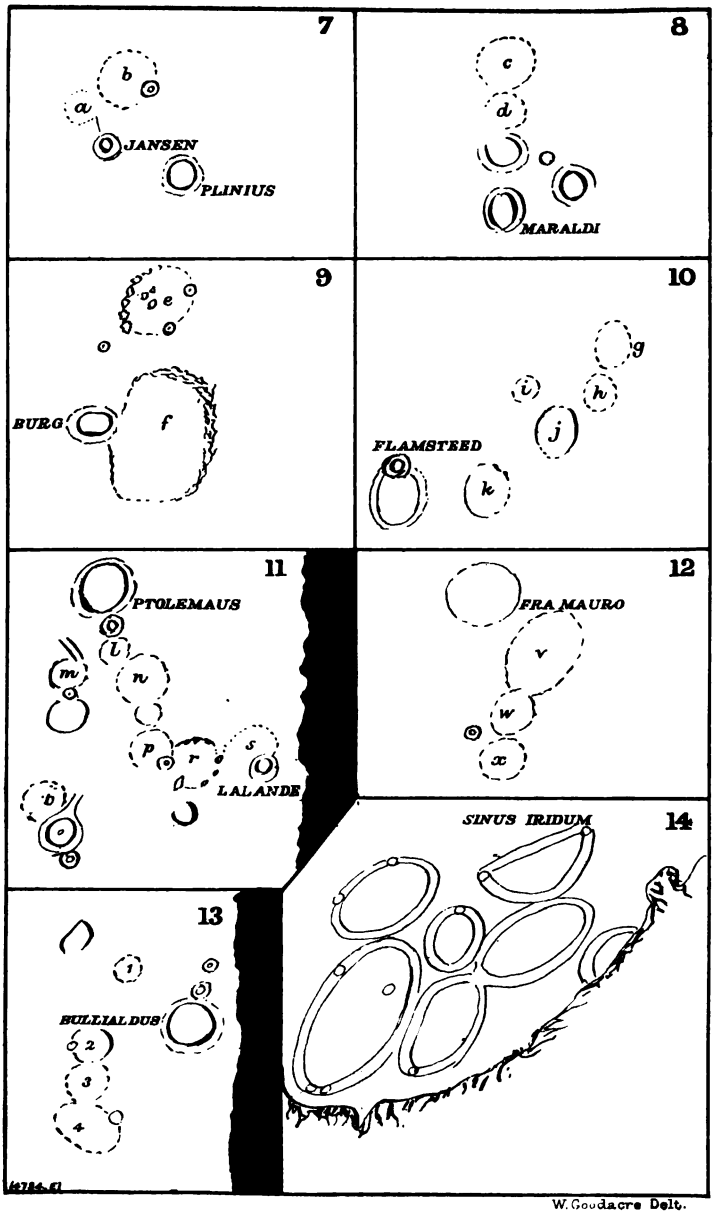

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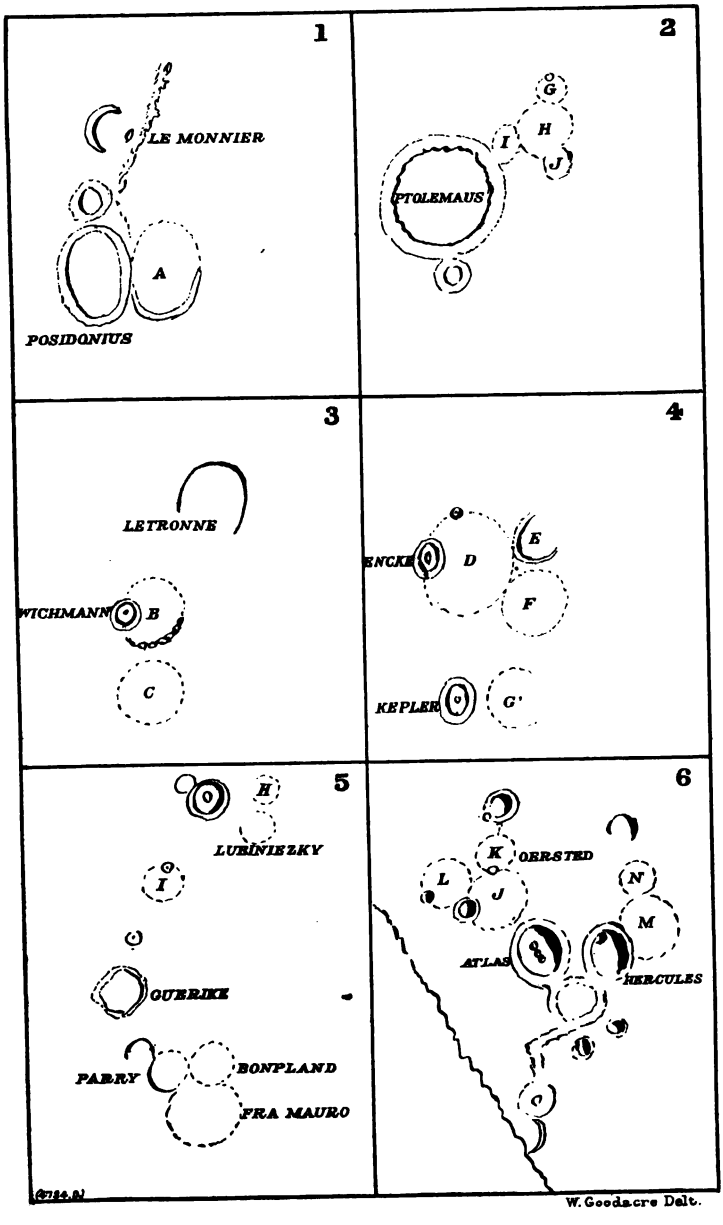

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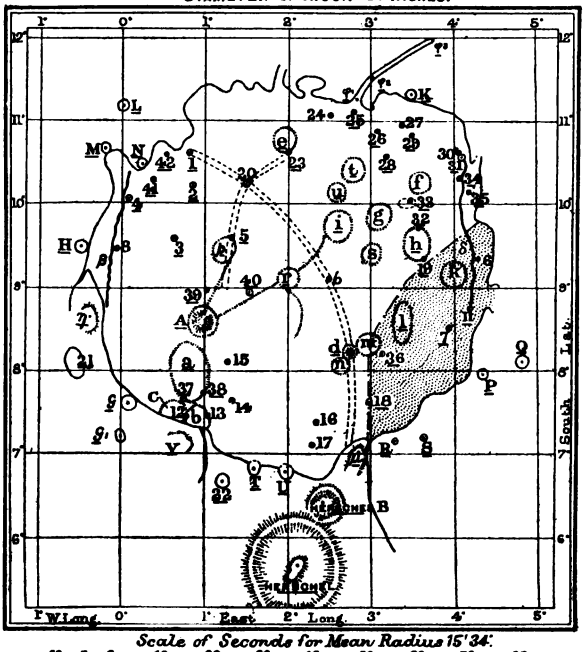
PTOLEMAUS.

DIAMETER OF MOON—50 INCHES.



Scale of Seconds for Mean Radius 15′ 34″.

70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80

Approximate Scale of Miles.

10 5 0 10 20 30 40 50 60 70 80 90

(4734.H.) *The true scale varies by about 2½ per cent.*

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SECTION FOR THE OBSERVATION

OF

JUPITER.

DIRECTOR.—REV. W. R. WAUGH, F.R.A.S.

SEVENTH REPORT OF THE SECTION.

REPORT FOR THE APPARITION OF 1897 AND 1898.

PART 1.

INTRODUCTORY.

As heretofore, this Memoir will be divided into five Parts. Part 1, is a general introduction; Part 2 a general account of the disk observations, with a more detailed account of the drawings selected for reproduction; Part 3 is a selection of various papers on Jovian features of interest and value; Part 4 consists of satellite observations; and Part 5, a condensed summary of the work with a few deductions therefrom.

The weather in the earlier portion of the apparition was very unfavourable for observing faint planetary details, hence the period covered by the observations has not been so long as on some previous occasions, though there is no reason to believe that there has been any slackening of interest.

The following is a list of the Members of the Section up to date, with the usual particulars.

Name.	Locality.	No. of Drawings.	Instrument.
WM. ANDERSON, F.R.A.S.	Madeira	8	5-in. O.G.
E. M. ANTONIADI, F.R.A.S.	Juvisy	—	—
E. ATTKINS	Highgate	—	—
E. G. AYLETT	Bredgar	—	—
Rev. J. BAIKIE, F.R.A.S.	Ancrum	—	—
G. BANASTER, F.R.A.S.	Tewkesbury	11	4-in. O.G.
W. M. BAXTER	Edinburgh	—	—

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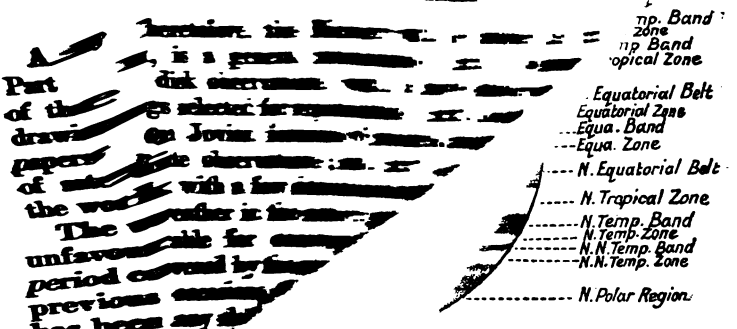

recognising the value of Mr. Crom-
lished in the Monthly Notices of the
y. He has well supplied the place of
Marth for all Jovian students.

h indebted to Dr. Smart, who has
S. for the use of his co-workers, and
on purposes. Dr. Smart's tables came
the publication of Mr. Crommelin's,
I. and II. for computing the longi-
s of the disk drawings; the coinci-
les from separate sources indicates

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Name.	Locality.	No. of Drawings.	Instrument.
LEO BRENNER	Lussinpiccolo	—	—
J. H. BRIDGER, MUS.B.	Farnborough	20	4-in. O.G.
G. L. BROWN	Stirling	—	—
R. W. BUTTEMER	Godalming	—	—
B. E. CAMMELL, F.R.A.S.	Wokingham	—	—
H. Y. CHILDS	Portland	6	4·5-in. O.G.
J. E. CLARK, B.A., B.Sc.	York	—	—
E. J. COPE	Malvern	1	8½-in. spec.
H. CORDER	Bridgwater	—	—
A. COTTAM, F.R.A.S.	Watford	1	12½-in. spec.
Rev. Dr. CRAIG, B.A., F.R.A.S.	Londonderry	—	—
R. CROSS	Oxford	—	—
E. W. ELLERBECK, F.R.A.S.	Scarborough	—	—
HY. ELLIS, F.R.A.S.	Potter's Bar	—	—
E. ESSAM, F.R.A.S.	Billingboro'	6	12-in. spec.
J. EVERSHED, F.R.A.S.	Kenley	—	—
R. FALCON	Workington	—	—
Rev. T. H. FOULKES, M.A.	Malta	5 parts	10½-in. spec.
A. FREEMAN	Hastings	—	—
W. F. GALE, F.R.A.S.	Newcastle, N.S.W.	—	—
W. GOODACRE, F.R.A.S.	Crouch End	—	—
H. F. GRIFFITHS	Streatham	2	6-in. spec.
ED. HALL	Bjorneburg	—	—
W. J. HALL	Nantwich	10	4⅞-in. spec.
G. P. B. HALLOWES, F.R.A.S.	York	—	—
A. HENDERSON	Liverpool	—	—
E. R. HICKS	Kensington	—	—
Rev. R. S. HUTCHINGS, F.R.A.S.	Salisbury	—	—
W. H. IZZARD	Brentford	—	—
J. JACKSON	Blackpool	—	—
W. E. JACKSON, F.R.A.S.	Liverpool	—	—
Rev. S. J. JOHNSON, M.A., F.R.A.S.	Bridport	Sats.	—
Rev. P. H. KEMPTHORNE, M.A., F.R.A.S.	Wellington College.	—	—
Rev. R. KILLIP, F.R.A.S.	St. Annes-on-Sea	11	5-in. O.G.
N. LATTEY	Cardiff	—	—
J. LUNT, B.Sc.	Ealing	—	—
HY. MACEWEN, F.R.A.S.	Glasgow	—	—
W. H. MAW, F.R.A.S.	Kensington	—	—
J. W. MEARES, F.R.A.S.	Calcutta	14	9½-in. spec.
A. MEE, F.R.A.S.	Cardiff	5	8½-in. spec.
F. K. MELLOR, F.R.A.S.	Huddersfield	—	—
P. B. MOLESWORTH, R.E., F.R.A.S.	Ceylon	52	12½-in. spec.
J. M. OFFORD, F.R.Met.S.	Ealing	3	12¼-in. spec.
J. ORR	Glasgow	—	—
Rev. J. D. PARKER, LL.D., F.R.A.S.	Stevenage	—	—
Dr. G. PATTERSON, M.A.	Ascot	—	—
Rev. T. E. R. PHILLIPS, M.A.	Yeovil	9	9-in. spec.
J. PHILLIPS	Hereford	2	12-in. spec.
W. T. PRICE	Wellington	—	—
Rev. V. REID	Glasgow	—	—
C. ROBERTS, F.R.A.S.	Kensington	—	—
Dr. RYLE, M.A.	Brighton	—	—

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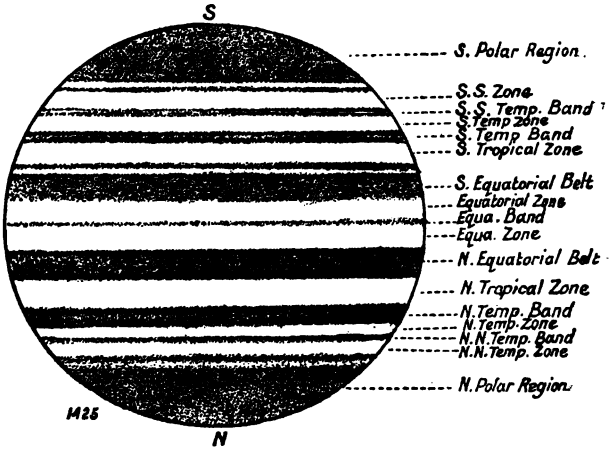
Name.	Locality.	No. of Drawings.	Instruments.
W. C. STEWART - -	Clapton - -	—	—
Dr. SMART, F.R.A.S. -	Bermondsey -	1	10½-in. spec.
C. F. SMITH - - -	Edinburgh -	17	5¼-in. spec.
H. F. SMITH - - -	Luton - -	16	6¼-in. spec.
Rev. W. SWINDLEHURST -	Wickham, N.S.W.	9	—
C. A. TAYLOR - -	London -	—	—
H. J. TOWNSHEND - -	Leeds - -	6	9½-in. spec.
J. M. WADMORE - -	Exmouth -	12	3·1-in. O.G.
Rev. W. R. WAUGH, F.R.A.S.	Portland -	11	4·5-in. O.G.
Rev. L. A. WILLIAMS -	New Shoreham -	—	—
A. STANLEY WILLIAMS, F.R.A.S.	Brighton -	—	—
H. WRIGHT - - -	Sydney, N.S.W.	2	8·5-in. spec.
J. WYKES - - -	Birmingham -	5	4·5-in. O.G.

We insert the adopted nomenclature diagram, its general acceptability justifying its continuance. It may be well to caution new members against its use for indicating latitude, though this is hardly necessary, as changes in latitude are abnormal this apparation, especially in the case of the two Equatorial belts, and the N. temperate band.



We have great pleasure in recognising the value of Mr. Crommelin's Jupiter tables as published in the Monthly Notices of the Royal Astronomical Society. He has well supplied the place of the much-regretted Herr Marth for all Jovian students.

Also the section is much indebted to Dr. Smart, who has supplied similar tables in MS. for the use of his co-workers, and also other figures for computation purposes. Dr. Smart's tables came to hand several weeks before the publication of Mr. Crommelin's, and refer to Marth's systems I. and II. for computing the longitudes of the central meridians of the disk drawings; the coincidence of the two sets of tables from separate sources indicates

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general accuracy. With pleasure we mention here two papers by Mr. J. H. Bridger, Mus.B., to facilitate the latitude and longitude finding of Jovian spots and markings, such as those recorded in the very interesting papers in Part 3. It is an indication of progress that qualified members of the section are issuing papers of this careful and useful character. Mr. H. Y. Childs has also assisted in some computations.

The total number of drawings sent to the director this apparition from observers in England has been 170, from observers in other lands 76, making a total of 246. Those not reproduced will be found in the Jupiter Album for 1897 and 1898.

As this seventh memoir is the last under the present Director, it may be well to call attention to the fact that while each memoir is complete in itself as a condensed record of the work accomplished by the co-operation of the several Members who have been assiduous during the apparition, to obtain a full view of the work of the Section it is necessary that the seven memoirs should be studied in their entirety; moreover, as references are constantly made to previous memoirs, we recommend that recent Members of the Section should possess themselves of the whole seven, and recur to them as occasion requires. Such references would soon give a good introduction, if not a complete mastery of Jovian literature. A thoughtful study of the disk reproductions alone would amply repay the small expenditure, as well as aiding the not over-supplied treasury. Moreover, increased funds would ensure more numerous reproductions in the future. The advantage of binding the memoirs separately, as well as collectively, is not to be overlooked where frequent reference is desired, and it only involves one extra copy. Perhaps the time of a change in the direction may be thought by some a suitable one for such separate binding. The retiring Director would call special attention to Jovian papers which have appeared in the Journal. They are by no means of an ephemeral character, and would have formed a portion of this or previous memoirs did they not seem to require a more immediate publication.

With great pleasure we call attention to the masterly "Beobachtungen der Jupiter" of Prof. Phil Fauth with 84 excellent reproductions of disk drawings and 5 well-arranged charts of the planet. They cover the apparition of 1896 and 1897, and form a valuable memoir of high-class work, and should be studied by all members of the section who are desirous of making progress in Jovian work.

PART 2.

Though in this Memoir the several workers have been permitted to speak for themselves of what they have achieved in Jupiter observing, the returns have been so copious and minute, that it was, as heretofore, found impossible to print *in extenso* a tithe of the material which has come to hand, hence the following description of the planet during the apparition is a condensed and collective *resumé* of the main features of drawings and reports, the latter being often of a fragmentary character.

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1. The equatorial zone has been decidedly darker than normal, especially in its northern portion, which often seemed a diffusion from the N. equatorial belt. In the earlier period of the apparition it was of a decidedly yellow colour, often with a reddish tone, both which tints gradually faded towards the close of the observing period. It was occasionally flecked with numerous ill-defined light masses, which, when definition was poor, gave it a mottled appearance. The faint equatorial belt was rarely seen, probably owing to the above over-lying material, and when glimpsed it was generally broken and diffuse. Wisps have been frequently seen on good nights. They were seen in all longitudes, and as a rule more diffuse than usual. They almost invariably seemed to spring from dark spots or protuberances on the N. edge of the S. equatorial belt. They rarely extended as far as the N. equatorial belt. The trend of these curious features was generally eastward, some being slightly curved as if affected by rotational drift. The average angle at which they stood in relation to the equator might be given at 45°, some few being, however, nearly parallel with the meridian line. During the previous apparition the influence of rotational drift on the wisps was not so apparent, as many of the positions stood at an angle opposed to it. Messrs. Phillips, Charles and Harold Smith, Meares, and Banaster, and Capt. Molesworth have been among the most successful in observing these weird objects.

2. The S. equatorial belt has been, on the whole, the most active of the Jovian features. The dividing line of light matter, giving the belt a duplex aspect, has been very apparent, all the good drawings to hand showing it, in many cases from limb to limb, except in the region of the bay, where it is arrested by the two shoulders. The following shoulder has been well marked, presenting the appearance of dark condensed material heaped up by the bay. The preceding shoulder has been far less conspicuous, but sufficiently so to form a clearly defined bay, in which the faint remains of the Great Red Spot still lie, and which has been very occasionally seen. It is the current opinion that it is more visible than last apparition. The very few among the 246 drawings of the sections which show it do not support this view. When shown it has a pale ghostly aspect, always so light in its central portion as to give it the appearance of a ringed nebula. Its present aspect gives little hope of its ever resuming the tint of its name. Messrs. Essam, Banaster, and Molesworth show it plainly. The trumpet-shaped rifts, chiefly on the N. edge, have not been much in evidence this appariton, only few observers showing them. There have been, however, a large number of dark and light spots of varied intensity, shape, and size, many of them projecting far into the equatorial zone.

3. The N. equatorial belt has, on the whole, been far less active than during the last apparition, though the abnormal disturbance has by no means ceased, as the diffused extension of its S. edge plainly shows, an extension which gave rise to the supposition that there was an additional belt. The main body of the belt has been very much attenuated. Both edges have had many light and dark spots. The S. edge had occasional extensions,

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giving that portion of the belt a wavy appearance. In drawings taken in February and March by Messrs. Killip, Charles Smith, and Offord this curious but evanescent feature is shown.

4. The S. temperate band has not been very conspicuous this apparition. Drawings by careful observers show it as little more than a straight line. On several, by the Rev. T. E. R. Phillips it is shown duplex, and occasionally there are wavy widenings of this belt. It has probably not attracted sufficient general attention, owing to its inconspicuousness.

5. The N. temperate band has been very attentuated and featureless during the whole apparition. Its latitude has gradually increased. Very recent measures seem to show that it is receding to its normal position, *see* 4th part. It does not appear at all on many drawings.

6. The two tropical zones have been fairly bright, but there has not been the average number of light well-defined spots on the S. tropical zone this apparition. The remarkable dark spots on the N. tropical zone have been closely observed by several. For particulars as to their rates of drift, *see* 3rd part, where tables of their periods are given.

7. The N.N. and S.S. temperate bands have been rarely seen. Messrs. Killip, Phillips, and Molesworth have been successful in detecting these difficult objects. The diffuse ringed aspect of the polar regions is an indication of their presence, and when seeing conditions are good they often yield to prolonged gazing.

8. On both polar regions there have been dark indistinct markings, seen as they ever must be, at a greatly foreshortened disadvantage, it is hardly likely they will awaken much interest. It is nevertheless true, that these regions are well worth more attention than they generally receive, and are likely to pay for special observation. The little that is known ought to be a stimulus to further application. Recent papers on their colouring by Mr. Bridger, and others, are a step in the right direction. A few diffuse markings have been seen on these regions. *See* Capt. Moleworth's work in the 5th part. The entire date-range of the drawings is from December 1897 to May 1898.

The general descriptions, as heretofore, will be arranged in six sections, embracing 60° of longitude each. Recent Members of the Section would do well to refer to the "Memoirs" for 1891 and 1892 for explanations of this arrangement.

The following is the usual condensed description of the drawings in each section.

Section I., longitude 0° *to* 60°.—There are 34 drawings in this Section. Nearly all are available for comparison. Traces of the Great Red Spot, chiefly of the following end, are shown in 7 drawings. In two cases the entire faint oval form is shown. The bay in which it lies is shown plainly in every drawing. The following shoulder is seen prominently in all, but the preceding shoulder is only well shown in 14 drawings. The S. equatorial belt is shown very prominently in all the drawings and duplex in the preceding portion in 14. In the following portion only in 12.

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Equatorial wisps are shown in 7 drawings, Messrs. C. and Harold Smith and Phillips being the most successful in detecting them. Light and dark spots and mottling are well shown in nearly all the drawings. The orange tint is well shown in 10. The drawings of Messrs. Phillips and Anderson show it prominently at the date of its greatest intensity.

The N. equatorial belt is shown faint and attenuated in all. The shading on its S. edge is shown on nearly all, and the faint S. component by Messrs. Molesworth, Killip, C. and H. Smith, Phillips, Banaster, Waugh, and others; its visibility being largely dependent on date.

The S. temperate band is shown by all, and the thickenings in various longitudes chiefly over the bay. The polar regions scarcely call for further remark here as they are fully discussed elsewhere. Messrs. Molesworth, Phillips, Killip, Childs, C. and H. Smith show traces of the fainter belts, especially those in the northern region. *See* Part 5.

Messrs. Phillips, Molesworth, Banaster, C. Smith, H. Smith, Waugh, Childs, Anderson, Killip, Bridger, Essam, Meares, Wright, and Hall contribute to this Section.

Section II., longitudes from 60° *to* 120°.—There are 24 drawings in this Section. They admit of comparison in about two equal portions as divided in longitude. One by Mr. Phillips shows a trace of the Great Red Spot near the limb, nine show the following shoulder, nearly all show the duplicity of the S. equatorial belt and its intensity, five show the orange colouring of the equatorial zone according to colour appreciation: Messrs. Offord, Phillips, Killip, Wykes, and C. Smith most clearly. Wisps are shown by Messrs. Offord, Phillips, and C. Smith. Light spots or markings are shown on this zone in 10 drawings, and dark spots on the N. edge of the S. equatorial belt on nearly all. Messrs. Meares, Banaster, Phillips, and Childs show them prominently. The N. equatorial belt is thin, but shows signs of more activity in some drawings in these longitudes, notably by Messrs. Offord, Molesworth, C. Smith, Killip, Phillips, Banaster, and Anderson. The S. component of the N. equatorial belt is shown on seven drawings, giving the aspect of duplicity to the belt in some cases, and in others that of an additional belt.

The S. temperate band is shown on 22 drawings. Mr. Offord shows it in some activity. The dark streak A is well shown on seven drawings. *See* Captain Molesworth's and Rev. T. E. R. Phillips' tables of its peculiar motion, &c. The N. temperate band is very attenuated, quite omitted in five drawings, only partially shown in a few; Messrs. Childs and Banaster show it slightly duplex. The polar bands are all shown very faint, except in the notable case of Capt. Molesworth's reproduced drawing, where the duplex and slanting N.N. temperate band is shown, with its three dark spots in $\lambda \pm 107°$ (*see* drawing). Dr. Smart shows this band duplex but parallel with the equator. The polar regions are normal, the N. being generally more dense. Messrs. Molesworth, Smart, Phillips, Bridger, Bannaster, Offord, Mee, Childs, Cottam, Offord, Wykes, Killip, Anderson, Hall, Wadmore, C. Smith contribute to this Section.

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Section III., longitudes 121° *to* 180°.—There are 20 drawings in this Section; 14 are comparable. The orange tint of the equatorial zone is shown in fully half, but varies in intensity, according to the time of observation; wisps are shown in six drawings, and some white markings in several. The S. equatorial belt is shown duplex in five drawings, and dark and light spots on the N. edge, most of which project into the equatorial zone in nearly all. Mr. Meares shows a white bay on the N. edge of the N. component of this belt; Messrs. Banaster, Bridger, Phillips, Mee, show the faint S. component of N. equatorial belt; and H. and C. Smith and Banaster show the S. shading partly covering the equatorial zone very clearly. The S. temperate band is shown in a disturbed condition in all the drawings by Mr. Phillips. In the N. tropical zone the streak A is shown in six drawings. Messrs. Phillips, C. Smith, and Banaster indicate the faint line attached to it, a feature referred to in Capt. Molesworth's returns. The N.N. temperate band is shown in four drawings, in some cases strongly.

The N. and S. polar regions are normal, very much as in the previous sections.

Messrs. C. Smith, Bridger, Essam, Meares, Hall, T. Phillips, Killip, Banaster, H. Smith, Anderson, J. Phillips, and Mee contribute drawings to this Section.

Section IV., longitudes 181° *to* 240°.—Over one half of the 27 drawings in this Section are fairly comparable. The ruddy tint of the equatorial zone is shown in all the drawings, notably those by Messrs. Killip, Phillips, and Meares. Messrs. H. Smith, Phillips, Killip, Childs, Molesworth, and Meares are successful in seeing the wisps. The faint equatorial belt is shown partially by Capt. Molesworth. This is unusual in this apparition. Light masses are shown by nearly all in this zone. The S. equatorial belt is shown duplex in nearly all. Mr. Anderson shows it wavy in outline. A light rift is shown in Mr. H. Smith's drawing in $\lambda \pm 180°$. Dark or light spots are shown on the N. edge of this belt in nearly all the drawings. In Mr. Meares' two drawings they are large and of striking aspect, inclining to the N. The N. equatorial belt is shown duplex in six drawings. This arises from the S. component being indicated more clearly in some than others. Several of the drawings of later date show increased activity in this belt, in these longitudes, notably Messrs. H. and C. Smith, Childs, and Meares. The S. temperate band is shown in all. In Mr. Phillips' drawing some activity is seen in its following portion (date, December 20). In Capt. Molesworth's the same activity is shown. He also shows a bay on its S. edge, with an oval spot lying in it, a miniature of the Red Spot. The S.S. temperate band is shown in the same drawing, also a faint streak in the N. tropical zone. Faint lines are indicated in several drawings in the N. polar regions, also more slightly in the S. polar regions.

Messrs. Bridger, H. Smith, Phillips, C. Smith, Essam, Killip, Childs, Anderson, Waugh, Meares, Molesworth, Hall, contribute to this Section.

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Section V., longitudes 241° *to* 300°.—There are 30 drawings in this Section, two thirds of which are comparable as to date. Ten show the orange tint of the equatorial zone, notably Messrs. Townshend, T. Phillips, Wykes, Killip, and Meares. Messrs. Banaster, J. Phillips, and Meares show wisps. The duplicity of the S. equatorial belt is shown in nearly all. Several spots are shown on the N. edge of this belt in 12 drawings. Messrs. Phillips, C. Smith, and Banaster show remarkable light spots on this belt. Mr. Griffiths shows a rift in λ 260° ±. The N. equatorial belt is shown in all the sketches—in some diffused—by Messrs. Banaster and Townshend as somewhat active. Mr. Meares shows a remarkable white spot on it, deflecting it northward in λ 240° ±. The dark streak in the N. tropical zone is shown by Messrs. Phillips, C. Smith, Banaster, Bridger, Meares, and Killip. *See* tables in Part 3. The S. temperate band is shown in all the drawings. Mr. Meares shows it thickened in the following portion. Mr. Phillips shows it duplex. Date, March 21.

The N. temperate band is attenuated in all the drawings where it is shown. Mr. Phillips shows the N.N. temperate band with markings on it. The polar regions are normal, Mr. Bridger and Mr. Mee showing the N. as of a steel blue; others show a bluish tint in both regions, but more marked in the N.

Messrs. Meares, Banaster, H. Smith, Waugh, Killip, Bridger, Griffiths, C. Smith, Phillips, Townshend, Offord, Essam, Wykes, Hall, and Mee contribute to this Section.

Section VI., longitudes 301° *to* 360°.—There are 39 drawings in this Section, seven of these showing the orange tint in the equatorial zone. Fourteen of the drawings show wisps, some diffuse, others as a well-defined line, all these wisps have their origin in spots or markings on the N. edge of the S. equatorial belt, and nearly all reach the N. equatorial belt. Mr. C. Smith shows a wisp-like marking as if drifting with the equatorial current. λ 340° to 350°. Date, March 31.

There are similar markings in a drawing by Mr. Offord. Date, 21st June. The S. equatorial belt is shown duplex in 30 drawings, with dark and light spots on the N. edge, or on the body of the belt. A drawing by Mr. Cope shows the belt in great activity and of abnormal form. The bay is well shown, in all the drawings, longitude permitting; in some cases on the limb; but the Great Red Spot is not shown on any except, perhaps, one by Mr. C. Smith, near the following limb, and by Mr. Phillips plainly. The preceding shoulder is generally at a lower angle than the following, as per date. Mr. Wykes shows the S. equatorial belt much disturbed, also do Mr. Mee and Mr. Harold Smith. A remarkable rift is shown in Mr. Hall's drawing; it debouches into the equatorial zone. Date, April 22. There is a remarkable light spot on the N. edge of this belt in Capt. Molesworth's drawing. Date, May 29. The N. equatorial belt is shown duplex in several drawings, but always very attenuated, though there are occasional thickenings. Mr. Cope's drawing shows some activity in this belt. The dark streak on the N. tropical zone is shown well on 16 drawings. *See* tables in Part 3.

The S. temperate band is shown on all the drawings, but without marked characteristics. The portion S. of the great bay

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evidently slightly overlies the position of the Great Red Spot. The polar regions are normal, Messrs. Bridger, Meares, C. Smith, and Wykes showing them bluish in tint, especially the N. *See* Mr. Bridger's paper in the "Journal."

Messrs. Wykes, Childs, Offord, Cope, Bridger, C. Smith, Molesworth, Hall, Meares, Banaster, Wadmore, Anderson, J. Phillips, H. Smith, Killip, Wright, Waugh contribute to this Section.

Mr. Wadmore sends six black and white drawings of Jupiter not included in the above discussions and not intended for the Album. Mr. Swindlehurst's pencil sketches, though possessing some interesting features, are also not susceptible of the above treatment.

Capt. Molesworth's drawings that are to be returned are also only partially included.

THE GREAT RED SPOT.

In view of the much debated question of the visibility of the Great Red Spot during the apparition of 1897 and 1898, the following condensed paper by Capt. Molesworth will be interesting. The paper is corroborated as to its facts by other competent observers:—

"The Red Spot is very faint, and with poor seeing is invisible. Good definition, however, shows the outline still distinct, and I have even seen a faint salmon tinge still on one or two occasions. As a rule, however, it appears colourless. The central portion is rather fainter than the rest, and on March 26, I saw a small circular white spot just following the centre.

"The Bay in which the spot lies is very distinct, both shoulders being clear cut. The following shoulder is very dark, with a slight projection to the S., very near the point of the shoulder. The preceding shoulder is a mere outline, the N. component of the belt being dark and knotted, while the S. component is straight and line like. Considerable changes took place in the neighbourhood of the shoulders during the observations.

"The Red Spot, even in its present washed-out state, appears to exercise an enormous influence on the envelope of Jupiter. Traces of this influence are visible for a considerable distance on either side in longitude; and in latitude from the S. temperate band to the N. tropical zone, and are too striking to be the mere result of coincidences.

The chief phenomena which appear due in some way to the influence of the Red Spot are the following:—

(1.) The repulsion of the S. equatorial belt causing the formation of the bay in which the spot lies.

(2.) Increased activity in the S. equatorial belt preceding the Red Spot, and decreased activity following it. This is borne out by the number of transits of spots (taken during the observations in the different zones of longitude), in the N. edge of the S. equatorial zone. This increase in activity appears to be progressive, as the figures are—

Long.	0°	to 90,	27 spots.
„	90	„ 180,	38 „
„	180	„ 270°	51 „
„	270	„ 360,	66 „

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(3.) The thickening of the S. equatorial belt in the same longitude as the spot, and its slight repulsion to the S.

(4.) The formation of various rapidly moving white spots in the S. temperate zone. These appear to form in the longitude of the Red Spot, and drift away in a preceding direction.

(5.) The absorption of the yellow tint, which is generally present in other longitudes, along the southern edge of the N. tropical zone.

The visibility of the Great Red Spot when near the limb is a very puzzling, but unquestionable phenomenon. It is much more distinct near the preceding than the following limb, but is visible right up to either limb. This may possibly be due to its being partially or wholly on a higher level than the rest of the surface.

The Director and other observers of the Section can endorse those views, except that marked No. 5, which may be attributable to other causes underlying the equatorial zone. The production of white spots, especially on the S. tropical zone, may arise from its heated condition as possibly indicated by its colour, a matter for still closer and prolonged observations in good air.

Capt. Molesworth's Micrometrical Measures of Jupiter.

Average Number of Settings, 6.—(*Abstract.*)

Date.	Trincomali, L.M.T.	Lat. of S. Eq. Belt.		Lat. of N. Eq. Belt, N. Edge.	Lat. of Centre of S. Trop. B.	Diameter of Planet.	
		N. Edge.	S. Edge.			Polar.	Equatorial.
1898.	h	° ′	° ′	° ′	° ′	″	″
Mar. 24	± 12	—	−13 44	+14 57	—	42·73	46·45
„ 25	9.45—12	—	—	—	—	43·00	46·12
„ 25	10.15—12	−2 41	14 20	14 13	—	39·13	—
„ 26	10.45—11.30	—	13 54	14 0	—	39·425	—
„ 28	10.30—11.30	—	13 52	13 14	—	42·48	44·10
„ 29	11—11.30	—	—	—	—	41·74	44·97
„ 31	10.80—11.30	3 42	—	—	—	41·735	43·962
May 5	6.15—6.45	—	12 12	12 30	—	37·455	—
„ 5	6.45—7.45	—	12 22	12 37	−23 39	38·243	—
„ 6	6.45—7.45	4 51	12 22	12 40	—	38·695	—
„ 10	5.45—6.30	—	15 21	15 31	24 18	38·192	—
„ 11	5.30—6.30	—	13 20	12 50	27 11	38·267	—
„ 12	5.20—6.15	—	13 15	14 45	—	38·311	—
„ 13	5.40—6.30	—	12 00	12 00	—	38·237	—
„ 14	5.30—6.30	—	16 01	14 25	—	38·282	40·551
„ 16	10.30—12.15	6 29	14 47	15 20	26 18	38·604	40·798
„ 17	5.30	—	—	—	—	—	—
„ 29	5.30—6.30	5 10	15 07	12 54	27 02	36·015	38·661
June 3	5.45—7.45	2 23	10 37	11 00	—	36·949	—
„ 5	6.0—6.30	—	15 26	13 06	—	37·090	—

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In the above measures, the most noteworthy matter is the gradual shifting northward of the N. edge of the S. equatorial belt. Indeed, there seemed to be a general instability in the whole belt. Sometimes its material appeared partially transfused over more than half of the equatorial zone. Possibly the strong yellowish tint of that zone was largely occasioned by such transfusion. This and the fact that several of the measures were taken in daylight, must have made micrometer work on the planet difficult, and possibly vitiate some of the figures. These results, however, show the patience, skill, and persistence of Capt. Molesworth, in attacking and conquering the difficulties incident to such work. In the full tables, weights and limiting longitudes are given. Conciseness required these and some other details to be omitted. The powers used on the micrometer varied from 150 to 305, showing that the state of the air was a large factor in the results.

DESCRIPTION OF THE PLATES.

Fig. 1, *Plate I., Long.* 3° (*H. Wright*). Date, May 25, 1898. —The following shoulder and bay were very definite.

Fig. 2, *Plate I., Long.* 7° (*Waugh*). Date, April 15, 1898.—The equatorial zone was a light orange with a mottled aspect. The S. equatorial belt was duplex and of a copper colour. The following shoulder and bay were very definite. On the margin of the bay there were three dark markings. There were several dark and light spots on the N. edge of this belt, which presented an appearance of considerable activity. The N. equatorial belt was far less prominent, and diversified with dark and light markings. The S. temperate band was wavy, and broken in parts. The N. temperate band was indistinctly seen. Both polar regions were banded in aspect, and of a greyish tint.

Fig. 3, *Plate I., Long.* 19° (*Harold Smith*). Date, April 8, 1898.—The equatorial zone shows traces of the faint equatorial belt, a pronounced wisp and several light markings.

The S. equatorial belt is duplex. The shoulder is very distinct and dark. There is a well-defined trumpet-shaped opening in the preceding portion of this belt. The N. edge of the belt has several dark and light markings. The bay is well seen, and there are traces of the new light spot in it. The N. equatorial belt is duplex with dark markings, connecting the two portions of the belt. Both tropical zones are light and slightly mottled. Both temperate bands are shown, and the S.S. temperate band is also seen, indicating good seeing. The N. polar region is the darker one, and of a steel grey. A drawing full of interesting detail.

Fig. 4, *Plate I., Long.* 33° (*Molesworth*). Date, May 3, 1898.—The equatorial zone is shown as of a deep yellow tint with four wisps, one of which extends right across the zone. The thin band in the northern portion is plainly shown. This feature is only seen under the best conditions. The S. equatorial belt is duplex, with six dark and three light spots on its N. edge.

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There is also a white spot near the apex of the shoulder. The bay is distinctly formed. The Great Red Spot is seen as an oval grey marking, having lost nearly all its colour. The N. equatorial belt is diffused in its S. edge. The S. temperate band has two prominent markings on it, and the S.S. temperate band is plainly seen. The N. temperate band is very faintly shown, with a dark marking on its *f.* portion. The N.N. temperate band is also shown with a similar marking. The dark spot on the N. tropical zone is faint, and seems to indicate that it is variable. The N. and S. polar regions are normal.

Fig. 5, *Plate I., Long.* 36° (*C. F. Smith.*) Date, February 16, 1898.—The equatorial zone is of a reddish yellow. The S. equatorial belt is seen duplex in its preceding and following portion. The bay being on the meridian is shown in its fullest extent. The following shoulder is dark and prominent, presenting a striking aspect. There are three striking projections on the N. edge of this belt. The N. equatorial belt is disturbed with projections on its N. edge. It is olive coloured with a gap on the C. M. portion. The S. temperate band is well seen, and of a broken aspect. The N. temperate band is very faintly shown. The N. polar region is steel grey, and the S. ruddy.

Fig. 6, *Plate I., Long.* 63° (*H. Y. Childs*). Date, April 23, 1898.—The equatorial zone is mottled by diffuse light markings. The S. equatorial belt is copper coloured and duplex. The following shoulder is dark and prominent. There are four dark spots, and one white one on the N. edge of the belt. The one N. of the shoulder being diffuse. The N. equatorial belt is duplex and attenuated. The N. temperate band is definite, and the N. temperate band is seen duplex. This feature of the band is verified by several observers, and is supposed to be objective. The N. and S. tropical zones are covered with many light spots. There are also light spots on the two temperate zones.

Fig. 7, *Plate II., Long.* 67° (*Arthur Mee*). Date, June 17, 1898.—The equatorial zone shows the yellowish tinge. The S. equatorial belt is duplex, the division being irregular. The shoulder is prominent. The N. edge of the belt shows dark curved projections, a not uncommon aspect. There are also a few white markings on the edge. The N. equatorial belt is dense with white markings on the N. edge. The S. temperate band is very definite. On the N. tropical zone there is the well-known dark spot, detached from the belt. The other zones are mottled. Both polar regions are bluish.

Fig. 8, *Plate II., Long.* 72° (*Dr. Smart*). Date, April 23, 1898.—On the S. equatorial belt, which is shown duplex, there are three dark spots. On the N. equatorial belt there are five dark spots. On the S. temperate band there are three dark spots. On the S. tropical zone there are three light spots. The N. tropical zone is also very light, with an indefinite marking on the following limb. The N. temperate band is distinct, and the N.N. temperate band is shown duplex, an unusual feature this apparition. Both polar regions are dark.

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Fig. 9, *Plate II.*, *Long.* 84° (*Cottam*). Date, April 16, 1898. —The equatorial zone is dark. The S. equatorial belt is well-defined, and of a chocolate colour. The N. equatorial belt is of the same tint, but much narrower. The N. temperate band is very slight. The S. temperate band is well-defined. The S. tropical zone is bright. The N. tropical zone is much duller. Both polar regions are dark.

Fig. 10, *Plate II.*, *Long.* 94° (*Wykes*). Date, June 5, 1898. —The equatorial zone is of a decided yellow colour. The S. equatorial belt is duplex and chocolate colour. The N. member of this belt has several diffuse spots on it, and has a curious marking trending southward very near the preceding limb. The N. equatorial belt is dark and much thinner, and has similar markings to the S. belt. The S. temperate band is unusually thin, the N. temperate band being the better defined. The polar regions are dark.

Fig. 11, *Plate II.*, *Long.* 107° (*Molesworth*). Date, May 18, 1898.—The equatorial zone of the usual yellow tint. There are several misty wisps preceding from the N. edge of the S. equatorial belt. The thin band in the N. portion of the zone is shown. The S. equatorial belt is irregular in both edges, showing considerable disturbance. There are several light spots on its surface, probably the division broken up. The N. equatorial belt is of a purple tint with four dark spots on its N. edge. The S. temperate band is irregular. The S.S. temperate band has two dark spots on its following portion. The N. temperate band is fairly well seen as compared with its usual aspect this apparition. The N.N. temperate band is duplex and angular with the equator, with three dark round spots near the meridian. The polar regions are dark purple.

Fig. 12, *Plate II.*, *Long.* 143° (*Killip*). Date, June 10, 1898. —The equatorial zone is orange-coloured. There are two wisps projecting at an angle from dark spots on the N. edge of the S. equatorial belt, on which belt there are three white spots giving an arched appearance to the belt. The N. equatorial belt is olive tinted. The S. temperate band is of the same tint, a light spot is seen on its preceding portion. There is an elongated dark spot on the N. tropical zone. Both polar regions are dark. There is a trace of the N. temperate band.

Fig. 13, *Plate III.*, *Long.* 151° (*Banaster*). Date, March 6, 1898.—The S. equatorial belt is seen very distinctly with three dark spots on its N. edge with associated white spots, imparting a bridged appearance. The N. equatorial belt is much narrower. Both belts are shown duplex. The S. temperate band is attenuated. There is a remarkable spot of a diffused aspect on the N. tropical zone, with a thin band projecting from its following end to the planet's limb; being at an angle to the equator it is noteworthy. The N. polar region is of a greyish tone.

Fig. 14, *Plate III.*, *Long.* 205 (*Meares*). Date, December 3, 1897.—On the equatorial zone there is a remarkable oval dark spot, apparently an extension of the N. member of the S. equatorial belt. From the spot and the belt there are two wisps.

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There is also a large white spot preceding the following wisp. The S. portion of the S. equatorial belt is attenuated. The N. equatorial belt is duplex, the N. member having a projecting spot to which the preceding wisp is attached. The S. tropical zone is bright. The S. temperate band is pronounced, with a small light spot on it. The N. temperate band is shown. The two polar regions are dark. Altogether a most remarkable drawing.

Fig. 15, *Plate III.*, *Long.* 243° (*Townshend*). Date, April 21, 1898.—The faint equatorial belt is just visible with a slight widening in about long. 200°. The S. equatorial belt is seen duplex, the southern member of which is irregular on its S. edge. On the northern division there are seen dark prominences, extending into the equatorial zone, which zone is seen of yellowish tint. The N. equatorial belt is much narrower, and has a wavy dark line extending over two-thirds of its length, there are also two white spots on this belt. Both temperate bands are faintly shown without any specific features.

Fig. 16, *Plate III.*, *Long.* 322° (*Offord*). Date, June 21, 1898.—The equatorial zone has a lengthened dark marking—very diffuse—probably not the faint equatorial belt. There is also a light marking on the following portion. The S. equatorial belt is divided, the N. portion being of a chocolate tint and the S. portion red. The belt is broken by a gap. The N. equatorial belt is also of a reddish brown colour, and mottled. The S. temperate band is very distinct, of a greyish slate colour. The N. temperate band is slightly shown. Both tropical zones are white and both polar regions are banded, the S. being slate coloured and the N. polar region being darker. Colouring is very distinctly seen by this observer.

Fig. 17, *Plate III.*, *Long.* 343° (*Cope*). Date, January 2, 1898.—The S. equatorial belt is shown as much contorted, with a slight belt in its S. portion. The N. equatorial belt is less abnormally formed, with extensions N. and S., that on the N. edge being very pronounced. The S. temperate band is broader than usual, and of a reddish brown tint. Both equatorial belts are of a very dark brown colour. Polar regions normal.

Fig. 18, *Plate III.*, *Long.* 355° (*Phillips*). Date, March 29, 1898.—These are traces of the faint equatorial belt and two wisps, with a wedge-form dark marking, possibly a more diffused wisp. The S. equatorial belt is duplex, the S. member being thin where it forms the preceding portion of the bay. The bay itself is well defined, the shoulder being very dark. The Great Red Spot is faintly seen. The inner portion of it being lighter giving the usual ringed appearance. There are two light spots on the N. edge of the belt. The N. equatorial belt is diffuse in its southern portion, and extends somewhat into the equatorial zone, giving the darkening aspect frequently seen at this date. The two tropical zones are very bright. The S. temperate band is duplex. On the N. zone there is a dark spot preceding. The N. temperate band is faintly shown. Also the S.S. temperate band. A most interesting drawing.

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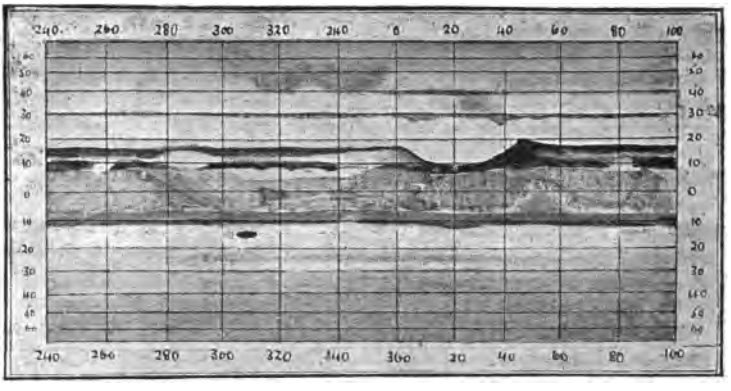
CHARTS.

It is a sign of progress that a larger number of these compact presentations of the markings of Jupiter has been returned. The Director asks attention to a special paper in the "Memoir" for 1896–97 on this important, and not very difficult mode of recording disk observations, implying as it does preparation and carefulness in observing. The charts are as follows:—

One of the whole surface, by Mr. J. H. Bridger, showing the more prominent markings. It is constructed from ten drawings made between April 15 and April 23 inclusive. As the interval is brief its value is enhanced. The relative positions of the two well-observed streaks on the N. tropical zone give their longitudes as approximately 120° and 300° for the above dates. A 4-in. O.G. was used. The chart is preserved in the Album.

One is returned by Capt. Molesworth, R.E. It is characterised by his usual care and skill. The amount of detail is very great; it is for the whole surface, and is in close agreement with those



by Messrs. Bridger and Smith. Nearly all the markings shown on his 52 drawings are reproduced on the chart, chiefly in the southern portions of the disk. It is matter of great regret that this exquisite chart cannot be reproduced in the "Memoirs," as it is to be returned to Ceylon. Capt. Molesworth has also returned a chart of Satellite III., which, of course, exceeds the results ordinarily obtainable. It is referred to in Part 3.

Capt. Molesworth has adopted the semi-transparent key, reference duly numbered, as in the charts of Herr Brenner, which makes them so convenient for comparison with the drawings.

One by Mr. C. F. Smith, which is reproduced here. It is constructed from drawings made from the end of March and the beginning of April. The inclusive longitudes are 100° to 240°. It shows considerable detail, especially in the equatorial zone and the S. equatorial belt. It is in fair agreement with that of Mr. Bridger.

The chief features of Mr. Smith's chart are thus described by him:—

Equatorial zone, yellow-orange in colour, with five diffused dark markings, one longitudinal one starting from a projection from the N. equatorial belt in λo.

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S. equatorial belt duplicate and active, with dark N. edge and dark and light spots thereon. Large oval white spot, about λ290. *p* and *f* "shoulders" high, the former appearing like an outline, owing to the great widening of the rift, *f* shoulder pointed towards the S. N. p. corner of bay very dark.

N. equatorial belt narrow, with dark N. edge. Latitude less than at last opposition, the equatorial zone being therefore narrower. Belt gray in colour.

S. temperate band not very dense, with usual thickenings over Red Spot.

N. temperate band very faint, and only partially seen.

N. tropical zone very white on S. side. Dark spot in λ310 surrounded by white aureola.

S.S. temperate band dark over Red Spot region.

S. polar region reddish, with two contiguous dark markings.

PART 3.

Transits of Spots, &c.

Capt. Molesworth's dark and white spots transits are very full and complete, but are far too copious for their reproduction. He also gives the transit of prominent features of the belts, and other markings, with powers used, definition, and interesting remarks where needed, occupying about 50 pages of foolscap MS., all of which refer to his 52 disk drawings, with a number of special sketches on the margin of his notes, all of which are elaborately drawn. He also gives four pages of diagrams illustrating the shiftings in longitude of carefully observed spots. The above remarks are due to Capt. Molesworth for his industry, skill, and perseverance in observing.

Dark Markings in N. Tropical Zone.

Denning's Letter.	Character of Spot.	Longitude at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h m s
A	A dark wisp, Prec. end	122	Mar. 24	July 1	20	9 55 27·8
	A dark wisp, Foll. end	131	Apr. 5	„ 1	17	
a	A shorter streak *p*. A, similar, but very faint.	80	May 3	„ 10	5	35·2
B	A short dark wisp, Prec. edge	266	Apr. 1	May 14	4	23·2
	A short dark wisp, Centre	267	Mar. 25	„ 31	3	
	A short dark wisp, Foll. end	268	Apr. 6	„ 14	3	
C	Diffuse streak, Prec. end	304	Mar. 25	June 20	20	24·4
	Diffuse streak, Foll. end	309	Apr. 7	July 2	17	

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White Spots in S. Temperate Zone.

Letter for Spot.	Character of Spot.	Longitude at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h m s
ζ	White spot	47	May 11	June 30	4	9 55 5·8
η	White spot	73	„ 11	„ 30	6	6·4
θ	White spot	97	June 1	July 10	4	9·0

The centre of the bay surrounding the Great Red Spot proved a difficult object to observe.

	Centre of bay	22	Mar. 26	July 10	16	9 55 41·9

The following rotation periods are deduced from transits observed by Mr. T. H. Bridger, who used an excellent 4-in. O.G. Though they are eye-estimates they have been taken with great care, the transit of the centre of the spot being taken in each case. The observations are corrected for the light equation, but not for the defect of phase.

Dark Spots in N. Tropical Zone.

A	Dark spot	124	Apr. 23	June 5	4	9 55 29·4
B	Dark spot	313	„ 17	„ 11	5	22·5

In computing the longitudes for both the above tables, system II. has been used throughout.

ROTATION PERIODS OF SPOTS determined by the Rev. T. E. R. PHILLIPS during the Opposition of 1898.

The longitudes of the spots included under the great equatorial current are based on System I. of Mr. Crommelin's Ephemeris for Jupiter, whilst longitudes of extra-equatorial spots are based on System II. During the opposition of 1898 the great equatorial current included the N. component of the S. equatorial belt, the equatorial zone, and the N. equatorial belt. The mean rotation comes out as $9^h\ 50^m\ 24^s{\cdot}2$ as computed by Mr. Phillips. Mr. Phillips concludes also from his observations that several of these spots exhibit great irregularities of motion; a conclusion corroborated by other trustworthy observers. The adopted periods of these equatorial spots varied between $9^h\ 50^m\ 15^s{\cdot}1$ and $9^h\ 50^m\ 33^s{\cdot}6$.

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Spots on N. Edge of S. Equatorial Belt.

No. of Spot.	Character of Spot.	Long. at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h. m. s.
I.	White -	28	Apr. 18	June 30	6	9 50 25·1
II.	Dark -	31	Mar. 28	July 5	4	28·0
III.	White -	60	Apr. 25	„ 5	7	28·6
IV.	Dark -	75	„ 25	June 19	5	19·7
V.	White -	88	„ 12	July 5	15	20·8
VI.	Dark -	100	Mar. 29	„ 5	12	21·9
VII.	White -	109	„ 22	June 1	6	22·2
VIII.	Dark -	119	„ 22	„ 17	8	27·8
IX.	White -	127	„ 22	„ 10	5	30·5
X.	Dark -	137	Apr. 23	„ 22	3	28·9
XI.	White -	146	Mar. 20	„ 22	13	27·9
XII.	Dark -	154	„ 13	July 15	14	28·5
XIII.	White -	276	„ 23	June 11	6	17·4
XIV.	Dark -	283	„ 14	„ 9	8	21·3
XV.	White -	310	„ 21	„ 16	6	17·9
XVI.	Dark -	323	„ 21	July 2	10	15·1
XVII.	White -	347	„ 21	June 30	11	23·3
XVIII.	Dark -	355	„ 21	„ 16	11	27·0
XIX.	„ -	353	June 5	„ 30	5	33·6

The motions of Spots V. and VI. were irregular. Spot VII. appeared on June 10 to have become united with another spot seen on June 1 in longitude 111°·1. Its observed positions after June 1 have, therefore, been omitted in deducing the rotation period. The observations of Spots XVI., XVII., and XVIII., made on May 15, indicate a very remarkable and sudden change in longitude. These vagaries of motion are, however, well corroborated by other observers. Spot XVII. was observed also on June 5 and 7, but it appeared double on these dates, and the positions have not been used in deducing the period.

Several other spots were observed in the above region, but satisfactory periods could not be determined.

The mean rate for spots on the N. edge of the S. equatorial belt was $9^h\ 50^m\ 24{\cdot}2^s$; but the period differed for different longitudes, as the following table will show:—

Approximate Longitude at ☌; 1898, March 25.	No. of Spots.	Mean Rotation Period.
		h. m. s.
From 75° to 109° - -	4	9 50 21·2
„ 119 „ 154 -	5	28·7
„ 276 „ 323 - -	4	17·9
„ 347 „ 60 -	6	27·6

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Spots on N. Equatorial Belt.

No. of Spot.	Character of Spot.	Long. at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h. m. s.
XX.	White, with reft.	129	Apr. 5	May 21	5	9 50 27·6
XXI.	Dark -	143	May 14	June 22	5	26·0
XXII.	„ -	323	„ 31	„ 16	3	19·9

The rate of motion of the N. equatorial belt seems to have approximated very closely to that of the N. edge of the S. equatorial belt. Thus, Spots I. and II. on the N. equatorial belt fall within the limits of that region of the S. equatorial belt which exhibited a period of $9^h\ 50^m\ 28{\cdot}7^s$.

Extra-equatorial Spots.

No. of Spot.	Character of Spot.		Long. at ☌.	Dates of Observations. First.	Dates of Observations. Last.	No. of Obs.	Mean Rotation Period.
			°				h. m. s.
XXIII.	The Red Spot - -		23	Mar. 29	June 19	8	9 55 42·4
XXIV.	Dark Spots in Lat. ± 40°.	Dark ellipse -	177	„ 23	May 12	6	6·2
XXV.		Dark condensation of S.S. Temperate Band.	343	May 4	June 16	9	7·8
XXVI.	Dark Spots on N. Tropical Zone. Lat. + 15°.	A.	128	Mar. 13	July 4	14	27·7
XXVII.		B.	264	„ 28	June 30	9	25·8
XXVIII.		C.	310	„ 21	July 10	17	24·5
XXIX.	Dark Streaks on N.N. Temperate Band. Lat. + 33°.	I.	40	Apr. 25	May 31	5	53·4
XXX.		II.	269	Mar. 21	June 4	8	49·8

The transits of the dark streak, No. XXIX., were taken of the preceding end. The motion of Spot No. XXVIII. was not uniform.

Mr. Phillips also gives a full and particular account of the aspect of the Jovian disks with many marginal pencil sketches which are shown in his drawings in the Album and utilised in Part 2.

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Speaking of the great equatorial current, Mr. Phillips writes: "The rate of motion of this current showed a very striking "increase as compared with that of previous years. In 1897 the "rotation period of the southernmost part of this current was "determined by Mr. A. Stanley Williams as $9^h\ 50^m\ 34^s{\cdot}6$."

The mean derived from his own observations as given in the foregoing tables is $9^h\ 50^m\ 24^s{\cdot}2$ or $10^s{\cdot}4$ less.

SPOT TRANSIT TABLES, by WALTER J. HALL.

The following are my eye-estimates of transits over the Jovian central meridian of 14 different positions on the N. and S.E. belts, with the rotation periods derived from them.

The first is believed to be pretty accurate, but the rest I have not felt justified in carrying beyond the nearest *second*. There is a wider difference between the highest and lowest rate of the nine spots on the N. edge of the S.E.B. than could be desired, no doubt a larger and better mounted instrument would diminish this, though I believe it is in part due to proper motion in the spots themselves. It is to be regretted also that some have only been observed to transit twice.

The mean times, however, given in the summary are thought to be a very fair approximation to the truth.

Ten selected drawings accompany this report to illustrate its points.

September 1898. WALTER J. HALL.

1898.

SUMMARY OF ROTATION PERIODS OF SPOTS.

Spot No.		h.	m.	s.	No. of Rotations.	
1	The Great Shoulder	9	55	43·3	128	
2	On the N. side of S. equatorial belt.	9	50	31	100	Mean of 9 spots $9^h\ 50^m\ 33^s{\cdot}2$.
3				33	66	
4				29	44	
5				24	88	
6				53	17	
7				45	17	
8				32	56	
9				12	17	
10				40	61	
11	On the S. side of N.E.B.	9	50	19	22	Mean $9^h\ 50^m\ 22^s{\cdot}5$.
12				26	61	
13	On the N. side of N.E.B.	9	55	20	63	Mean $9^h\ 55^m\ 21^s{\cdot}5$.
14				23	122	

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1898.

LIST OF DARK EQUATORIAL WISPS, by WALTER J. HALL.

No.	Approximate Position of S. extremity. (System I.)	Issuing from Spot on S.E.B.	To Spot on N.E.B.	Dates Observed.
α	9°	No. 2	—	February 22, April 4 (part way across on latter date).
β	33	„ 3	—	March 8, April 4.
γ	47	„ 4	—	April 16, May 4 (short on latter date).
δ	75	„ 5	No. 11 (λ 82°)	April 16, 18, 25, May 4.
ε	153	„ 7	—	April 12, May 12.
ζ	188	—	—	May 3.
η	227	No. 8	—	April 1.
θ	253	—	—	April 1.
ι	282	No. 9	—	February 24, March 14, 21.
κ	322	„ 10	No. 12 (λ 327°)	February 24, March 3, 14.

PART 4.

SATELLITE OBSERVATIONS.

Though the number of satellite observations is not so large as in 1897, it is believed that they have improved in accuracy. Owing to the illness of Mr. Gale, who was our largest contributor on the last apparition, the returns from New South Wales will not be forwarded until the end of 1899. Captain Molesworth's returns will supply this deficiency. A short abstract of the markings Captain Molesworth observed on Ganymede and Callisto will be found at the end of this Part. He solicits corroboration when atmospheric conditions permit.

The Rev. S. J. Johnson, M.A., sends as follows. He also adds that "at the end of a period of eclipses of Satellite IV. some short "unpredicted ones may occur. Such might have been the case about "the 9th or 20th of April 1898, but cloud precluded observation on "those dates." It will be easy to calculate corresponding dates. Mr. Johnson also adds the following interesting note: "In an old "number of the 'Intellectual Observer' for October 1864, "page 225, on a supposed fifth satellite of Jupiter, there is a "paragraph as follows:—'M. Camille Flammarion,' writing in "'Cosmos' observes, 'that M. de Gasparis of Naples saw on the "'22nd of July at 7^h 59^m p.m. a black well-defined spot on the "'planet's disk; in a quarter of a hour this black point, moving

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" ' in the direction of the planet's rotation disappeared, passing
" ' from the margin. M. de Gasparis asks if this is the same body
" ' that has been seen by Messrs. Long and Baxendall. M. Flam-
" ' marion says it could not have been a planet (asteroid?) in
" ' conjunction with Jupiter, for in that case its motion would
" ' have been in the opposite direction, and it was not one of the
" ' four well-known satellites, as they were all visible.' Could it, he
" asks, have been a fifth small satellite ? "

PHENOMENA OF JUPITER'S SATELLITES.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
Feb. 8	I. Tr. E.	External contact.	10 58 15	10 58 —	H.	Seen under poor conditions.
Feb. 23	II. Tr. E.	Bisected	11 0 0	—	H.	
—	—	External contact.	11 2 45	11 3 —	H.	Definition fair.
—	I. Oc. R.	First seen	11 44 0	—	H.	
—	—	External contact.	11 46 0	11 46 —	H.	Definition good.
—	I. Oc. R.	First seen	11 45 30	—	K.	
—	—	Clear	11 47 0	11 46 —	K.	
Mar. 3	I. Tr. E.	Internal contact.	10 35 0	—	H.	
—	—	Bisected	10 41 0	—	H.	
—	—	Clear	10 43 30	10 42 —	H.	
Mar. 10	I. Sh.	On Central Meridian.	11 0 0	—	K.	Shadow well defined. Sudden sea fog.
—	I. Tr. I.	External contact.	10 11 0	10 13 —	H.	Definition fair.
Mar. 20	III. Oc. R.	First seen	8 55 0	8 56 —	H.	
Mar. 26	IV. Sh. I.	Just after external contact.	4 5 —	4 15 —	M.	Distinct penumbra.
—	IV. Sh.	On Central Meridian.	4 21 —	—	M.	Noted after C.M. passage.
—	IV. Sh. E.	—	5 4 —	4 59 —	M.	
—	IV. Conjn.	—	4 13 —	—	M.	Just clear of N. limb.
Mar. 27	I. Oc. D.	One diam. from limb.	5 10 —	—	M.	
—	—	External contact.	5 15 —	—	M.	Poor definition.
—	—	Gone	5 19 —	5 19 —	M.	
Mar. 28	I. Sh.	On Central Meridian.	3 43 —	—	M.	Shadow noted as smaller than satellite.
—	I. Sh. E.	Half off	4 46 30	—	M.	
—	—	Off disk	4 48 30	4 52 —	M.	
—	I. Tr. E.	Internal contact.	4 40 0	—	M.	No ellipticity noted before egress.
—	—	External contact.	4 44 30	4 48 —	M.	
Apr. 4	I. Tr. E.	Bright on disk.	6 8 —	—	M.	P. edge brighter than f.
—	—	Do.	6 15 —	—	M.	Distinctly elliptical.
—	—	Internal contact.	6 25 0	—	M.	Perfectly circular.
—	—	External contact.	6 29 25	6 32 —	M.	Do. do.
—	I. Sh.	On Central Meridian.	5 27 0	—	M.	Faint irregular penumbra.

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
Apr. 5	I. Ec. R.	Invisible	3 54 0	—	M.	
—	—	Bright	3 59 0	3 55 45	M.	First glimpse not seen.
Apr. 7	III. Tr. I.	External contact.	2 25 30	—	M.	
—	—	Internal contact.	2 42 0	2 33 —	M.	
—	—	Invisible	3 0 ±	—	M.	P. edge vanished $2^h\ 53^m$.
—	—	Grey streak	3 16 0	—	M.	
—	III.	On Central Meridian.	3 42 30	—	M.	Grey spot, darker nucleus.
—	—	—	4 23 0	—	M.	Part brighter than disk.
—	III. Tr. E.	Internal contact.	4 50 30	—	M.	
—	—	External contact.	5 4 0	5 6 —	M.	
—	III. Sh. I.	First contact.	3 36 30	—	M.	
—	—	Internal contact.	3 44 30	3 40 —	M.	
—	III. Sh.	On Central Meridian.	4 59 30	—	M.	Shadow larger than satellite.
Apr. 12	I. Ec. R.	First glimpsed.	5 47 30	—	M.	
—	—	Nearly bright.	5 49 0	—	M.	Elongated N. and S.
—	—	Fully bright.	5 50 35	5 49 40	M.	Disk normal.
—	II. Oc. D.	External contact.	5 45 40	—	M.	Appeared as a bright point while just inside.
—	—	Gone	5 49 10	5 50 —	M.	
—	II. Ec. R.	First seen	9 10 59	9 10 51	B.	Air steady.
—	—	Bright	9 13 32	—	B.	
—	II. Ec. R.	First seen	9 11 —	9 10 51	H.	
—	II. Ec. R.	First seen	9 11 30	9 10 51	J.	
—	—	Bright	9 14 0	—	J.	
—	II. Ec. R.	First seen	9 10 30	9 10 51	K.	
—	—	Bright	9 12 0	—	K.	
Apr. 17	I. Oc. D.	First contact.	10 27 55	—	B.	Steady air.
—	—	Bisection	10 29 34	—	B.	
—	—	Disappearance.	10 31 30	10 31 —	B.	
—	I. Oc. D.	Last seen	10 32 45	10 31 —	H.	Definition fair.
Apr. 18	I. Tr. E.	Bisection	10 2 41	—	B.	Rather unsteady.
—	—	External contact.	10 4 23	10 2 —	B.	
Apr. 19	I. Ec. R.	First seen	7 43 15	—	B.	Twilight.
—	—	Bright	7 44 44	7 43 43	B.	Rather unsteady.
—	I. Ec. R.	First seen	7 44 21	—	J.	
—	—	Bright	7 45 55	7 43 43	J.	Twilight.
Apr. 21	III. Tr. I.	Internal contact.	9 12 0	9 11 —	E.	
—	III. Tr.	On Central Meridian.	10 15 0	—	E.	Bright circular image of satellite plainly seen on N. temperate band; a dark brown shadow on W. side of spot.

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
Apr. 25	I. Tr. I.	External contact.	9 32 0	9 33 —	H.	Conditions fair.
—	—	Internal contact.	9 35 0	—	H.	
May 2	III. Oc. D.	One diam. from limb.	2 6 0	—	M.	
—	—	External contact.	2 15 30	—	M.	
—	—	Gone	2 24 30	2 20 —	M.	Very gradual.
—	III. Oc. R.	Easily visible.	4 54 0	—	M.	
—	—	Clear	5 4 30	5 2 —	M.	
—	III. Ec. D.	Fading	5 36 0	—	M.	
—	—	Semi-oval	5 41 0	—	M.	
—	—	Gone	5 46 25	5 45 35	M.	Gradual.
May 5	I. Ec. R.	First glimpse.	5 57 36	—	M.	No change in shape.
—	—	Fully bright.	5 59 48	6 0 46	M.	
—	II. Tr. E.	Contact.	9 34 0	9 34 —	K.	Satellite seemed unusually long in getting away.
—	—	Quite clear	9 40 0	—	K.	
May 6	I. Sh.	On Central Meridian.	2 6 0	—	M.	Very black.
—	I. Tr. I.	Internal contact.	2 22 0	—	M.	Elongated E. and W.
—	—	Off	2 27 0	2 29 —	M.	
May 7	II. Ec. R.	First glimpse.	6 13 52	—	M.	
—	—	Fully bright.	6 20 30	6 19 31	M.	
May 11	I. Sh.	On Central Meridian.	9 31 0	—	B.	Wind, but clear. Earlier than predicted in E.M.
May 12	I. Ec. R.	First seen	7 56 30	7 55 11	H.	Observed when the sun had hardly set. Though it took 2m to come into full view. It was then in conjunction with II.
—	II. Tr. I.	External contact.	9 24 0	9 23 0	H.	Definition fair.
—	—	Internal contact.	9 27 0	—	H.	
May 13	I. Tr. I.	External contact.	2 1 0	—	M.	
—	—	Internal contact.	2 3 30	2 2 —	M.	
—	—	On disk	2 10 0	—	M.	Still bright, elliptical E.W.
—	—	Do.	2 25 0	—	M.	Just visible, brighter than disk.
—	—	Do.	3 57 0	—	M.	
—	I. Tr. E.	Internal contact.	4 13 0	—	M.	Slight ellipticity.
—	—	External contact.	4 16 0	4 18 —	M.	
—	I. Sh.	On Central Meridian.	3 57 30	—	M.	Small; round.
—	I. Sh. E.	Internal contact.	5 8 5	—	M.	Very black.
—	—	Off	5 12 5	5 17 —	M.	
—	III. Sh.	On Central Meridian.	0 52 30	—	M.	Black penumbra.
—	III. Sh. E.	Internal contact.	1 58 30	—	M.	Suspected.
—	—	Off	2 8 30	2 15 —	M.	

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
May 14	II. Oc. D.	First contact.	4 19 0	—	M.	
—	—	Gone	4 22 30	4 22 —	M.	
—	II. Ec. R.	First seen	8 55 28	8 56 6	B.	
—	—	Bright	8 57 36	—	B.	Steady air.
May 16	II. Tr. E.	Off	1 13 0	1 8 —	M.	
—	II. Sh.	On disk	1 15 0	—	M.	On S. component of S. temperate band.
May 18	I. Tr. I.	First contact.	9 25 0	9 24 —	K.	For 10m afterwards the satellite was brilliant.
—	—	Well on	9 27 0	—	K.	
—	I. Tr. I.	External contact.	9 21 37	9 24 0	B.	Good definition.
—	—	Bisection	9 24 19	—	B.	
—	—	Internal contact.	9 26 47	—	B.	
—	I. Tr. I.	First contact.	9 23 0	9 24 —	H.	
—	—	Internal contact.	9 26 0	—	H.	
May 21	I. Ec. R.	Fully bright.	4 18 0	4 18 25	M.	
May 23	IV. Oc. D.	Contact.	9 34 0	10 17 —	E.	The approaching satellite appeared round and bright, gradually fading as it neared occultation on the polar region of Jupiter. Reappeared a little higher; very faint.
—	IV. Oc. E.	Glimpsed	11 43 0	11 7 —	E.	
May 28	II. Oc. D.	First contact.	9 13 0	—	H.	Definition poor.
—	—	Gone	9 16 0	9 17 —	H.	
May 29	I. Tr. I.	Internal contact.	0 14 0	0 10 —	M.	
—	I. Tr.	On disk	1 0 0	—	M.	Visible as a grey spot.
—	—	On Central Meridian.	1 14 30	—	M.	Fading.
—	—	On disk	1 47 0	—	M.	
—	—	Do.	2 5 0	—	M.	Invisible.
—	—	Do.	2 11 0	—	M.	Satellite reappeared; faint.
—	—	Do.	2 17 0	—	M.	Satellite suddenly bright.
—	I. Tr. E.	Internal contact.	2 2 0	—	M.	
—	—	External contact.	2 23 0	—	M.	Satellite circular.
—	I. Sh. I.	Do.	1 18 30	—	M.	
—	—	Internal contact.	1 21 0	—	M.	
—	I. Sh.	On Central Meridian.	2 24 0	—	M.	Shadow appeared larger than the grey satellite.
May 30	I. Ec. R.	First glimpsed.	0 38 50	—	M.	
—	—	Fully bright.	0 41 30	0 41 42	M.	
June 1	I.	Near elongation.	3 50 ±	—	M.	Unusually bright.
June 4	I. Oc D.	External contact.	4 38 7	—	M.	
—	—	Gone	4 41 2	4 42 —	M.	

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
June 5	I. Tr. I.	Before Ingress.	2 0 0	—	M.	Bright. Pale yellow.
—	—	External contact.	1 55 45	—	M.	
—	—	Internal contact.	2 1 45	2 2 —	M.	Circular.
—	I. Tr.	On disk	2 4 0	—	M.	Equatorial region of Sat. brighter than poles.
—	—	Do.	2 9 0	—	M.	Elongated p. edge.
—	—	Do.	2 19 0	—	M.	Barely perceptible.
—	I. Sh.	Do.	4 50 0	—	M.	Shadow intensely black.
June 8	I.	Against sky	1 55 2	—	M.	Satellite unusually faint.
June 9	IV. Oc. D.	First contact.	2 21 30	—	M.	Satellite very dull.
—	—	Last contact.	—	2 47 —	M.	Not seen.
—	IV. Oc. R.	First contact.	4 3 30	4 17 —	M.	Difficult, owing to small angle with planet.
—	—	Clear	4 31 —	—	M.	
June 10	I. Tr. I.	External contact.	9 25 21	—	B.	Steady air.
—	—	Bisection	9 27 39	9 27 —	B.	
—	—	Internal contact.	9 30 11	—	B.	
—	I. Tr. I.	External contact.	9 23 0	—	H.	Definition fair.
—	—	Internal contact.	9 26 0	9 27 —	H.	
—	I. Tr. I.	External contact.	9 25 0	—	K.	Satellite seen well on the limb at $9^h\ 35^m$.
—	III. Tr. I.	Do.	10 17 52	—	B.	Air currents.
—	—	Bisection	10 23 24	10 23 —	B.	
—	—	Internal contact.	10 27 34	—	B.	
—	III. Tr. I.	External contact.	10 20 0	—	H.	
—	—	Bisection	10 26 0	10 23 —	H.	
—	—	Internal contact.	10 31 0	—	H.	
June 10	III. Tr. I.	First contact.	10 21 30	—	K.	
—	—	Well on	10 27 0	10 23 —	K.	
June 11	I. Ec. R.	First seen	10 2 18	10 2 33	B.	Steady.
—	—	Bright	10 3 54	—	B.	
—	I. Ec. R.	First seen	10 30 0	10 2 23	H.	Difficult to observe owing to cirrus clouds covering the planet.
June 13	II. Sh.	On Central Meridian.	1 29 0	—	M.	Small round and black.
—	—	On disk	2 35 —	—	M.	On passing off elongated.
June 21	I. Tr.	On Central Meridian.	1 27 —	—	M.	Circular grey dot.
—	I. Sh. I.	Internal contact.	1 34 25	1 34 —	M.	
—	I. Sh.	On disk	1 50 0	—	M.	
—	III. Ec. D.	Fading	9 42 45	9 41 11	J.	
—	—	Gone	9 47 10	—	J.	
June 22	II. Ec. R.	First seen	11 16 45	11 15 25	J.	
—	—	Bright	11 20 5	—	J.	

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
			h m s	h m s		
June 28	I. Tr. I.	External contact.	2 11 0	—	M.	
—	—	Internal contact.	2 13 20	2 13 —	M.	Circular and bright.
—	I. Tr.	On disk	2 19 0	—	M.	Elongated. E. and W.
—	—	Do.	2 22 0	—	M.	Do. Bright.
—	—	Do.	2 25 0	—	M.	Do. Bright.
July 4	I. Ec. R.	First seen	10 16 20	10 15 50	J.	
—	—	Bright	10 18 30	—	J.	
July 6	I. Oc. D.	First contact.	1 11 50	—	M.	
—	—	Gone	1 15 5	1 17 —	M.	
July 20	I. Ec. R.	—	8 36 40	8 34 25	J.	Very strong twilight.

CONJUNCTIONS OF SATELLITES.

Mar. 22	I.	II.	—	—	B.	
„ 22	I.	II.	—	—	H.	
May 6	II.	III.	—	—	H.	III. being to the N.

Observers.

B. = BRIDGER, T. H., Farnborough, Hants, 4-O.G.
E. = ESSAM, EDWARD, Billingborough, Lincolnshire.
H. = HALL, WALTER J., Lindum House, Nantwich.
J. = JOHNSON, REV. S. J., Melplash, R.S.O., Dorset, 3½-O.G.
K. = KILLIP, REV. R., St. Anne's-on-Sea, Lancashire, 5-O.G.
M. = MOLESWORTH, CAPT. P. B., Trincomalee, Ceylon.

In closing this part we subjoin the following remarks by *Mr. H. J. Townshend* on Satellite I. He states he saw it of a reddish brown colour when on the disk of the Primary. He also refers to the well known fact that, *in transitu*, it is often lost to sight, and that it has been often seen grey and dark grey in colour. The fact of its being seen brownish was confirmed by another observer independently at the same time. Mr. Townshend thinks it suggests some variation in the physical condition of certain areas of Jupiter, since it could not be optical or the result of complementary colouration.

Capt. Molesworth in his copious and valuable returns has given an interesting *resumé* of the satellite observations and studies. We much regret that the limitations of space necessitate a mere abstract, especially as the subject of satellite markings is a moot question among those whose keenness of sight and instrumental equipment qualify for the work. We may hope that

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Capt. Molesworth may give to the astronomical world, the whole of his observations on this difficult and important department of scientific enterprise. Meanwhile this brief thesis, chiefly in his own terse language, is here presented as a stimulus to exertion in these fascinating pursuits.

Io,—*I.*

"No markings whatever have been seen on I. whilst against "the sky, in which position it appears absolutely circular, and "of a bright pale yellow, only inferior in albedo to II. During "transits at ingress and egress this satellite has often been seen "to become elongated when just inside the limb, often attaining "a very high degree of ellipticity, 1·20—1·35. This was noted "on almost every occasion, (*e.g.*, April 4th, May 6th–13th, &c.) "and was not easy to explain at first. On June 5th, however, "with a power of 600, the definition being very sharp, the "reason for the apparent elongation was clearly seen at ingress. "The equatorial portion of the satellite is seen as a bright "ellipse on the duller circular disk, for as the satellite in the "course of transit passes in front of the gradually brightening disk "of Jupiter, the faint circle ceases to be visible against the back-"ground, and only the bright equatorial ellipse can be made out. "This is generally visible from 15 to 20 minutes after the first "contact, and becomes fainter and more diffused as the satellite "advances. About 20 to 25 minutes after first contact the "satellite becomes invisible, reappearing a few minutes later as "a grey spot, which gradually darkens as it nears the C.M. "I have, however, never seen it darker than a dull grey (about "the same darkness as the normal dark spots of the S. equatorial "spots), and never black. It also generally appears much smaller "than one would expect. The same appearances take place in "the reverse order at egress, except that the satellite seems to "remain grey rather longer, and the change from dark to light "seems to be more sudden than at ingress. The explanation of "these changes is, I think, that the axis of rotation of I. is ap-"proximately parallel to that of Jupiter, the poles of the satellite "being dull and deficient in reflective power, compared with the "equatorial regions. Two of my observations this year seem to "point to the possibility of variation in the light of this satellite. "It was seen on June 1, 1898, near elongation unusually bright, "and on June the 8th in haze I considered it after a careful "comparison with the other satellites unusually faint. I would "suggest that careful observations be made, preferably by an "observer accustomed to variable star work, with a view to "confirming this supposed variability and the discovery, if pos-"sible, of its rotation period. The shadow of I. in transit is "neat, sharp, circular, and intensely black. I have once or twice "suspected a slight penumbra."

Making due allowance for the inferiority of English air to that of Ceylon, other observers, including the Director, can substantially confirm nearly all the above, with reference to satellite variability.

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Europa,—II.

"The reflective power of II. seems to surpass any of the others; "when close to either III. or IV. it forms a great contrast, "especially with the latter. No ellipticity has been noticed, nor "have markings of any kind been detected during these obser- "vations. It usually appears sharply defined, and of a brilliant "pale yellow, I do not remember having seen a dark transit of "this satellite. The shadow during transit appears smaller than "one would expect, and, I think, is darker at the centre than at "the edges, but I have not been able to trace any defined "penumbral ring. It was suspected as slightly elongated N. and "S. on June 17."

Ganymede,—III.

"This satellite is by far the largest of the four, but inferior in "'albedo' to I. and II. It is, however, immensely superior "to IV. In colour it is usually of a pale primrose yellow. "Markings were distinctly seen on the disk of this satellite, both "during transit and against the sky." This interesting feature is shown in many careful sketches. At first nothing definite is shown on the sketches, except faint equatorial shades and suspicions of darker spots on transverse markings. On April 7th, however, "the curtain rose" during transit (to quote Mr. Douglas's expressive simile) M.N., LVIII., 7 May 1898), and a darker streak inclined to the equatorial belt was distinctly seen. (A chart of the markings is given, which it is hoped may be reproduced by the Council on some future occasion.) This had been seen, but not so well on the previous night, and observations on successive nights, and different hours of the same night, showed a direct axial rotation in about 23 hours. Independent drawings were obtained afterwards whenever possible.

"And the same marking was again picked up and carefully "followed whilst visible. A second similar marking was also "detected about 110° of longitude after the first. These were "carefully checked, and central meridian transits obtained with "as much accuracy as the minuteness of the object would permit. "The rotation period was deduced independently from the obser- "vations of each of these two spots (called A and B), and the "periods thus obtained were found to be in very close agreement "with each other. The mean apparent rotation period from "these two spots was found to be $22^h\ 59^m\cdot0315$, equalling a "mean sidereal rotation period of $22^h\ 59^m\ 10^s\cdot65$." The full data from which this period is obtained are given in a tabular form, here omitted from want of space. On the basis of this rotation period Capt. Molesworth has worked out a complete ephemeris. It is omitted for the same reason. The Director will give a copy to any who can use it. Capt. Molesworth has also worked out the central meridian of the whole of the 66 sketches of the satellite taken during the observations.

Capt. Molesworth further says, "As far as I can judge the "axis of rotation is inclined about 70° or 80° to the plane of "the primary's equator, the N. pole being slightly turned

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"towards us during the observations. In addition to the dark "markings a very white minute (polar?) spot has been seen on "a good many occasions, as nearly as I can judge, at the N. "end of the axis of rotation. I have fancied this spot slightly "excentric."

Capt. Molesworth naturally says, "I feel a certain amount of "diffidence of these results, in view of the fact, that Lowell and "Douglass, with far more perfect means, have come to entirely "different conclusions, while Prof. Pickering with the Lick 36-in. "can only see faint equatorial shades, and the polar spot. I am, "however, quite certain of the reality of these markings, and "have actually seen the displacement from hour to hour on the "same night. When the definition is 5 on my scale, the equatorial "belt can usually be made with a power of 340, and I have "detected it once with a power of 305. I may also point out "that my instrument, although small beside the colossal telescopes "at Lick and Flagstaff, is very perfect in its way, and very "massively mounted. The air here is often magnificent for "planetary detail, and the satellite was observed continually on "every occasion when definition was good, for nearly three "months.

"The whole of the 66 drawings of the satellite thus obtained "agree very well among themselves, considering the minuteness "of the disk, and the difficulty of estimating the exact centre. "The connected ephemeris was not made out until after all the "observations were finished, and in no case was even the approxi- "mate longitude calculated until I had finished the sketch. "Probably Mr. Douglass' markings and mine are the same, but "our representations of them are each tinged with the personal "peculiarities of the observer. I cannot account for his adoption "of the longer rotation 'period,' as under favourable conditions "the shift of the markings from hour to hour can be well seen "with a power of 500 or 600.

"When near opposition the disk of III. was frequently sus- "pected as elliptical, the longer axis not always lying the same "way, and its direction appearing to have no relation either to "its rotation period or to its period of revolution round Jupiter. "These observations are given in tabular form, but their discordance "seems to indicate the possibility of optical or atmospheric causes.

"The shadow of III. during transit is very large and black, "I have seen it surrounded with a narrow penumbral ring, and "have suspected an irregular extension of this ring in a north "preceding and south following direction." (*Drawing of this is given in the notes. Also a complete chart of the markings.*)

Callisto,—IV.

Second to III. in size, but by far the faintest of the four, the contrast with a high power being very great when IV. is in the same field with another satellite. The colour is a dull pale blue.

Markings were detected on it when against the sky, but these were only visible under very favourable conditions, owing to the faintness of the disk, and were at once blotted out by the slightest haze or bad seeing.

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The most distinct marking was an ill-defined white polar one at the S. edge of the disk, from which faint shades usually diverged. A very faint lightening was also suspected once or twice at the s. p. limb. "I suspect a fairly rapid rotation, pro- "bably more rapid than that of III., but my data are insufficient "to make a wild guess at its period." The disk of IV. was suspected elliptical on several occasions near opposition, the inclination of the major axis being fairly constant, making the angle roughly 90° with the equator of Jupiter. The shadow on the only occasion when it was seen was not altogether on the disk, at egress a distinct penumbra was visible, but not when near C. M.

PART 5.

In closing this "Memoir" the Director would like to call special attention to the comprehensive papers by W. F. Denning, F.R.A.S., on the history of the Great Red Spot from its earliest date to its recent aspect, and on the rotation periods of other important spots and markings in No. 9, of Vol. 58, of the "Monthly Notices" of the Royal Astronomical Society. The same number contains also a valuable report of observations of the planet by Mr. Gledhill at Bermerside, Halifax. This paper deserves close study, and may well form a model for the returns of every Member of the Section, especially to those who are the possessors of a micrometer.

As a general view of the aspect of the planet's disk has been given in Part 2, instead of the usual closing *resumé* we prefer giving extracts from some of the more formal returns of the Members of the Section.

1st. THE GREAT RED SPOT.—*Capt. Molesworth's* remarks are given in a separate paper (*supra*).

Mr. Essam.—"The Great Red Spot was well seen on April 15, 1898. It was of a ringed appearance, having lost much of its pinkish tint, appearing now of a light grey colour. The aureola was very white and distinct."

Mr. Banaster.—"On the 17th of April I had a beautiful view of the Great Red Spot. At times I fancied I could trace the complete oval, but the eye may have guessed at the more indistinct preceding portion unconsciously. I am inclined to think it faded off, or merged into a bright streak preceding the spot, and so I have tried to show it on the sketch. Some rather rapid change must have taken place in the 'bay.' For this spring the following has been steep and sharp, but on April 17, when the spot was so well in view, the preceding shoulder was the more pronounced."

The Rev. T. E. R. Phillips.—"This, the most interesting feature of the Jovian disk, was carefully looked for, and though in poor air extremely difficult, and usually invisible (with the exception of a fragment at its following end), was several times

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well seen when definition was good. At first the spot presented the appearance of a dusky oval ring, rather darker at its S.F. end, but as the apparition advanced, the ringed aspect seemed changed into the appearance of a very faint oval shading, gradually darkening to the S.F. portion. The colour of the spot was grey, not a trace of red being suspected, and throughout the apparition the spot was in contact with the S. temperate band. The bay in which the spot lies was well defined, the following shoulder as during the previous apparition being deeper and very much darker than the P. shoulder. The material within the bay was exceedingly brilliant. The spot itself never seemed central in the bay, but always displaced towards the F. end, its C.M. transits appearing to take place about three or four minutes later than those of the centre of the bay. Sketches accompany this account. Changes, otherwise than in colour, may fairly be inferred from the above account."

EQUATORIAL ZONE.—*Capt. Molesworth.* "The general tint of the equatorial zone is an orange yellow, shading in parts almost to brown, and lightening to all degrees of white at the brighter parts, from a dull yellowish white to a brilliant, almost phosphorescent, milk white. The delicacy of these gradations and the softness of the shading of the wisps quite defy reproduction. I can imagine no more beautiful sight than this region when studied with a large aperture under really good conditions, and it is absolutely impossible to give any idea of the marvellous detail visible. The brighter parts almost invariably occur in the zone immediately N. of the darkest parts of the N. edge of the S. equatorial belt. The faint wisps crossing this zone are difficult objects as a rule, and require sharp definition to see them well. They are, I think, rather darker this year than last, but are very fugitive objects, and do not appear to be at all permanent. They almost invariably take their rise in one of the dark spots in the N. edge of the S. equatorial belt, and cross the equatorial zone at almost any angle, generally in a straight line, but sometimes more or less curved. As a rule, adjacent ones are more or less parallel, but this is not an invariable rule, and two or more wisps frequently diverge from the same spot. The wisps are, as a rule, darkest in the south, fading gradually northwards, and making the equatorial zone under moderate definition appear as if it was darkest to S. and shaded away gradually to the N. In some cases the wisps appear to terminate at the faint N. central equatorial belt, and not to reach the N. equatorial belt. They appear to be a faint grey, but colour in such delicate objects is doubtful."

The Rev. T. E. R. Phillips.—"The whole of this zone, with the exception of the brilliant white spots, was of a deep orange, and at times almost of a coppery hue, especially near its N. edge. The colour was most marked, and appeared decidedly stronger than during last apparition. For some months there was seen a dusky line or band running close to the N. equatorial belt and parallel to it, and apparently physically connected with it, by material of a somewhat ruddy colour. It was difficult to say whether or not this band was the old S. component of the N.

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equatorial belt, which had survived from the previous year. Later on, however, this dusky streak was observed to retreat gradually further and further from the N. equatorial belt, and in the end, though still perhaps somewhat N. of the equator, seemed to be identical with the well-known faint equatorial belt. The white spots detached from the S. equatorial belt varied a good deal in size and appearance, sometimes being small and well defined, and at other times being large and much diffused.

"The wisps seen on the equatorial zone were, generally speaking, neither quite so numerous nor so attenuated as during the apparition of 1896–97. Now and then a narrow transverse line was seen connecting the equatorial belts, but as a rule the wisps appeared as diffused dusky markings. One interesting point was observed in connexion with these shadings. For some months their trend seemed to be almost in every case from S.P. to N.F.; subsequently they were observed to be generally perpendicular to the belts, and at the end of the apparition the direction in most cases was from S.F. to N.P."

Mr. Harold Smith.—"The colour of the equatorial zone was reddish (possibly partly accounted for by haze). A wisp was seen near the preceding limb towards the N. equatorial belt. The whole of the equatorial region was very hazy and cloud covered with white spots near the equator."

Mr. Charles Smith.—"There were two dark shadings on the equatorial zone, one on each side of a rift in the S. equatorial belt." Probably diffused wisps. He also speaks of faint shadings connecting the equatorial belts. Also that the zone was very yellow, with faint projections into the zone from the S. equatorial belt. (*See* Mr. C. Smith's excellent drawings in the Album.)

Mr. Wadmore speaks of the equatorial zone as dusky pink.

Other observers briefly corroborate the more prominent features of this interesting portion of the planet's disk.

THE SOUTH EQUATORIAL BELT.—*Capt. Molesworth.* "Colour, a fine warm grey, deepening at the following shoulder and the part following into an almost ruddy purple. It is apparently the most disturbed region of the whole planet, especially as regards its N. edge. This activity appears to be at a maximum, both for light and dark spots, in the region just preceding the Great Red Spot, and at a minimum just following it. The changes in the belt take place with bewildering rapidity, and the identification is most difficult. The belt is rifted almost continuously throughout, the rift being of varying width and brightness, and changing rapidly from night to night. The central rift breaks out here and there into the equatorial zone, appearing to force back and contort the dark matter on either side of the 'break-out' (called rifts by some observers). The greatest activity in the belt appeared to occur at the end of May and the beginning of June. In spite of numerous observations for longitude, I was unable to detect any uniform drift in the markings in this belt. The juxtaposition of the brightest and darkest marking is dealt with elsewhere." Space forbids the insertion of these observations.

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The Rev. T. E. R. Phillips.—"As usual this prominent belt was of a deep red or chocolate colour, and divided by a narrow rift of white material, widening considerably as it approached the P. shoulder of the Red Spot Bay into two components having very different rotation periods and widely dissimilar in appearance. The N. component was in a state of considerable disturbance, being interrupted by sundry rifts, and otherwise broken up by numerous dark and white spots, projecting into the equatorial zone. These white and dark spots were usually arranged alternately. (A discussion of their rotation is found in Part 3.) It may, however, be stated here, though tentatively only and with considerable doubt, that the white spots appeared to be at a somewhat higher level than the dark, there being at least one instance in which a white spot seemed to overtake, pass over, and obliterate its P. dark neighbour. The S. component of the belt was much quieter than the N., although one or two definite markings were seen, and apparently indicated a rotation slightly quicker than System II. These were bright spots on the rift dividing the two components of the belt. These spots were sometimes of great brilliancy, and owing to the difference in the rotation of the dark material bounding them, exhibited rapid and striking changes of form." (Here follows four careful pencil sketches of these phenomena, which it is hoped Mr. Phillips will still further elaborate and issue in a specific article for the "Journal.")

The Rev. T. H. Foulkes sends sketches of this belt which corroborate many of the above remarks, especially the alternating of white and dark spots and the activity of the N. edge of the belt.

Mr. Bridger.—"The S. equatorial belt is duplex in some parts. The preceding shoulder being much less definite than last year, and the belt is divided (I think) all round, the following shoulder being dark." Several other observers corroborate the above as to duplicity of belt, the alternation of dark and light markings on the N. edge, and the general disturbance of the N. component. *Vide* the drawings of Messrs. Essam, Charles Smith, Wadmore, Harold Smith, and other observers.

THE N. EQUATORIAL BELT.—*Capt. Molesworth.*—"Dark but very narrow, the N. edge being sharp, the S. edge being diffuse, and often shading away insensibly into the wisps. The colour is a steel grey, with possibly a faint purple tinge, merging near some smoky streaks into a brown grey. It is very uniform in darkness and density, with no striking irregularities, with only here and there a tendency to form darker knots, which sometimes give the northern edge a wavy appearance; one of these knots generally occurs as the preceding edge of each of the streaks already mentioned."

The Rev. T. E. R. Phillips.—"There was a striking diminution in the latitude and in the intensity of this belt. The alteration in the latitude was observed visually only, but was very apparent. As regards the diminution in intensity it will be remembered that during the previous apparition the N. equatorial belt had developed in the most remarkable manner and with

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wonderful rapidity into quite the most disturbed region of the disk. The disturbances were, however, comparatively short-lived, and some time before the planet was lost in the sun's rays the belt showed signs of returning to a state of quiescence. These indications were abundantly fulfilled, for in the late autumn of 1897, as soon as the planet emerged from the sun's rays sufficiently for observations to be recommenced it was found that the broad and much disturbed belt of the previous apparition had again dwindled down to a comparatively peaceful looking belt."

Mr. Banaster.—"The N. equatorial belt has been seen duplex on many nights, and wavy and mottled throughout. The N. edge has been better defined than the S. I frequently saw a well-defined line running N*f* in a slanting direction well to the edge of the disk. I am convinced this line must have run spirally round the planet and joined the N. temperate band, which from being pretty well invisible (only a hair line in good air) became afterwards quite an easy object." Mr. Banaster uses a very superior equatorial.

The Rev. T. H. Foulkes speaks of the N. equatorial belt as very irregular on its S. edge, and of a connexion between the N. edge of the belt and the spot A. on the N. tropical zone. This connexion is shown in three sketches of that portion of the disk.

Mr. Bridger.—"The N. equatorial belt strongly suspected as duplex, especially the following end. Also that the width has diminished, and that the division was increasing so that the S. portion had encroached on the equatorial zone."

Mr. Wadmore speaks of the irregularity of the N. equatorial belt with faint excrescences on its N. edge.

SOUTH TROPICAL ZONE.—*Capt. Molesworth.*—"Regular and intensely white, the most uniformly white portion of the whole planet (except the brilliant white spots of the S. equatorial belt and the red spot bay). Its breadth is very constant. It appears to be liable to the formation of minute white spots, which are very slightly lighter than the ground of the zone, and are correspondingly difficult to see well."

This portion of the disk has been overlooked of late, but it is full of interest, especially in the region of the Red Spot.

NORTH TROPICAL ZONE.—*Capt. Molesworth.*—"This zone is intensely white in the same longitude as the Red Spot, but as a rule has the rest of its southern portion more or less merged with yellow. The yellow colour is clearer and brighter than the tint of the equatorial zone, and is generally more pronounced in the neighbourhood of the smoky streaks, A, D, &c." These streaks are fully dealt with in Part 5.

The Rev. T. E. R. Phillips.—"This zone, though still very bright, was much less so, and not so brilliant as during the previous apparition, when it was unquestionably the brightest part of the disk. An interesting feature of this region was a narrow line running parallel to the N. equatorial belt. This line was fairly conspicuous during the early part of the apparition, but either from decreasing intensity, or bad seeing, subsequently

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became very difficult, and at the close of the apparition invisible. The three prominent elliptical or elongated dark spots (A, B, C) (*see* tables) were really intensifications of the dark line above mentioned, but the spot A at times appeared connected by a narrow ligament with the N. edge of the N. equatorial belt. The drawings of Mr. Foulkes corroborates this. Whether the connexion was complete, however, may be doubted, as the rotation periods of the spot and belt were so different (*see* the tables), from which it may be seen that there has been a marked increase in the rate of the drift of the surface material of this zone."

All the observers write of or draw one or more of these dark streaks, and they are fully discussed in the tables and shown in the drawings.

Mr. Bridger corroborates the connexion between the spot A and N. equatorial belt.

SOUTH TEMPERATE BAND.—*Capt. Molesworth.*—"Dark and knotted, the colour being almost always a faint blue. The belt broadens out at several points, and has been sometimes seen double at these broader places. The outline of the southern edge appears to be slightly distorted in the neighbourhood of certain spots. This band is certainly the darkest and most important of the minor belts."

The Rev. T. E. Phillips.—"When seeing was good this belt was distinctly double; at all events, in places. It was not uniform in breadth or intensity, but contained a number of dark and bright spots, which moved with much greater rapidity than the Great Red Spot. It was interesting to watch one bright spot in particular gradually drifting past the latter" (*see* drawings).

Mr. Banaster.—"I have fancied several times that the S. temperate band was double. It has been well seen all through the spring."

Mr. Bridger.—"The S. temperate band has generally appeared regular and uniform, though of varying width and distinctness in different longitudes."

Mr. Harold Smith.—"This band was narrow in longitude, ± 157°, but widening considerably E. and W."

NORTH TEMPERATE BAND.—*Capt. Molesworth.*—"This band has almost disappeared, and can only be seen well under good definition. It is very faint throughout, straight and narrow. It is rather darker and broader near streak A, but even there it is extremely faint."

All the other observers, by drawings and description, corroborate the above as having no distinctive features.

THE N.N. TEMPERATE BAND.—*Capt. Molesworth.*—"Fairly dark and distinct, of a delicate bluish gray. Double for a considerable distance, and in parts inclined at a slight angle to the other bands. In one or two places shoulders were formed, and in one instance a definite darker bay enclosing a dark elongated spot (E), rather like a minature Red Spot, and apparently due to similar causes."

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The above statement is most interesting and important, and is in part corroborated by the drawings of other observers, especially by Messrs. Banaster and Phillips.

SOUTH POLAR REGIONS.—*Capt. Molesworth.*—"Smooth and uniform as a rule, with less appearance of striation than the N. polar regions. The tint is generally of a pale grey, with a faint tinge of yellow, and once or twice I have fancied a very faint bluish tinge."

Mr. Banaster speaks of this region as of indigo grey.

NORTH POLAR REGIONS.—*Capt. Molesworth.*—"Usually of a pale bluish grey, seen, however, on rare occasions with a distinctly yellowish tinge. Under good definition it frequently presented a lined or striated appearance, as if consisting of innumerable parallel lines. This appearance was most marked in longitude 330° — 60°."

Mr. Banaster speaks of this region as much darker than the south.

Drawings and many observers corroborate these aspects of both polar regions, but they need to be made a specialité.

W. R. WAUGH,
Director of the Section.

1899, February 23.
Portland.

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OBSERVATIONS OF JUPITER, 1898.

Fig. 1. H. Wright, 8½ in. Spec.
1898, May 25, 23 h. 30 m. Long. 3°.

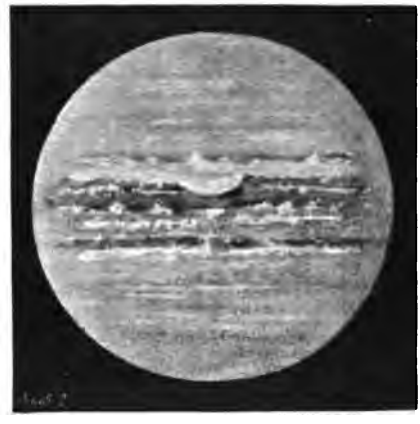

Fig. 2. W. R. Waugh, 4.5 in. O.G.
1898, April 15, 10 h. Long. 7°.

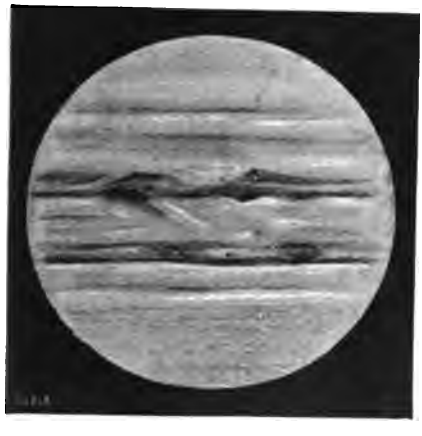

Fig. 3. H. F. Smith, 6½ in. Spec.
1898, April 8, 9 h. 30 m. Long. 19°.

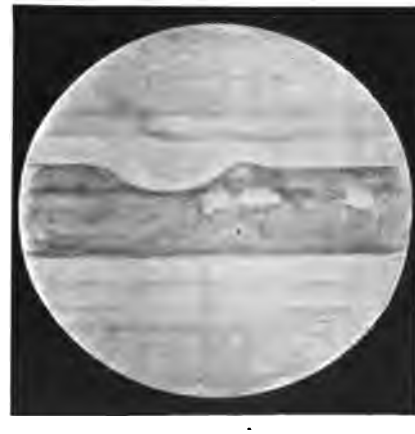

Fig. 4. P. B. Molesworth, 12½ in. Spec.
1898, May 3, 5 h. 41 m. Long. 33.8°.

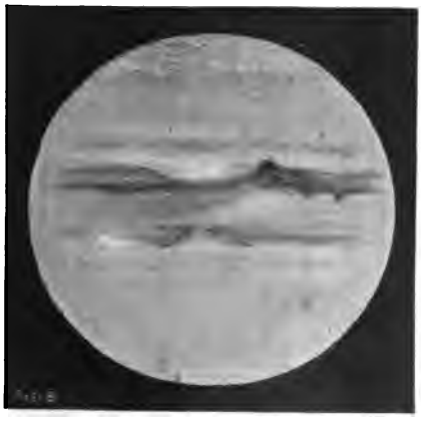

Fig. 5. C. F. Smith. 5¼ in. Spec.
1898, Feb. 16, 13 h. 5 m. Long. 36°.

Fig. 6. H. Y. Childs, 4.5 in. O.G.
1898, April 23, 8 h. 10 m. Long. 63°.

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OBSERVATIONS OF JUPITER, 1898.

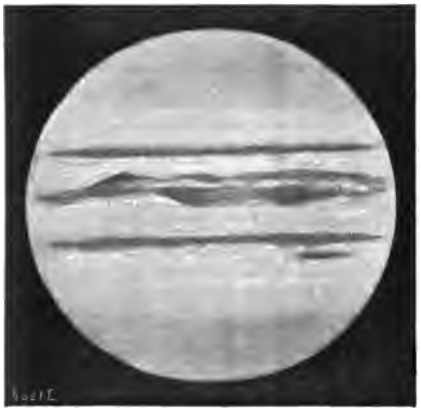

Fig. 7. A. Mee, 8½ in. Spec.
1898, June 17, 8 h. 45 m. Long. 67°.

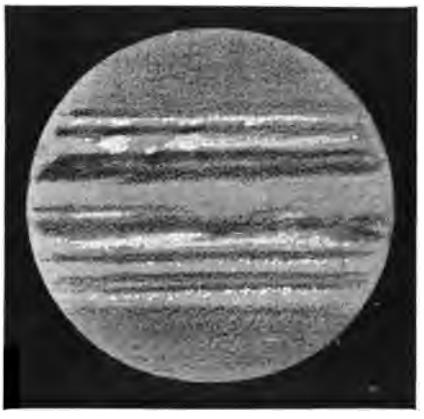

Fig. 8. D. Smart, 10½ in. Spec.
1898, April 23, 8 h. 30 m. Long. 72°.

Fig. 9. Arthur Cottam, 12½ in. Spec.
1898, April 16, 8 h. Long. 84°.

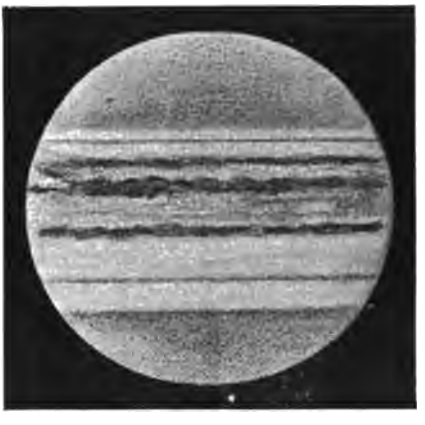

Fig. 10. J. Wykes, 4.5 in. O.G.
1898, June 5, 9 h. 35 m. Long. 94°.

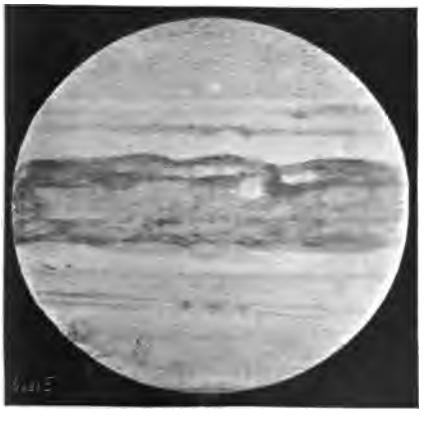

Fig. 11. P. B. Molesworth, 12½ in. Spec.
1898, May 18, 5 h. 5 m. Long. 107.8°.

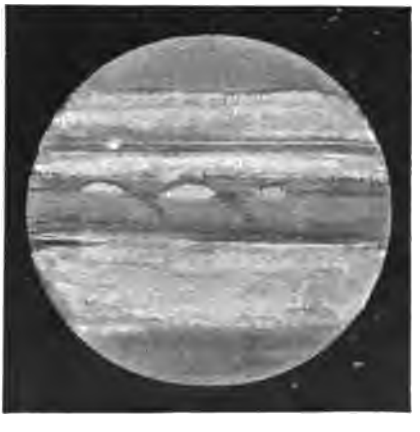

Fig. 12. Robert Killip, 5 in O.G.
1898, June 10, 10 h. Long. 143°.

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OBSERVATIONS OF JUPITER, 1897-1898.

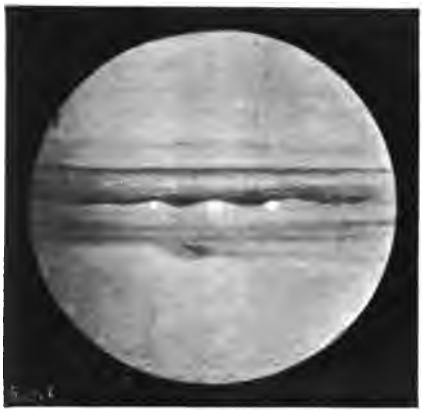

Fig. 13. G. Banaster, 4 in. O.G.
1898, March 6, 11 h. Long. 151°.

Fig. 14. J. W. Meares, 9¼ in. Spec.
1897, December 3, 13 h. 14 m. Long. 205°.

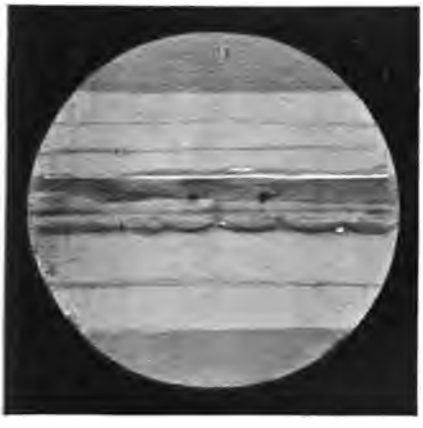

Fig. 15. H. J. Townshend, 9½ in. Spec.
1898, April 21, 11 h. Long, 243°.

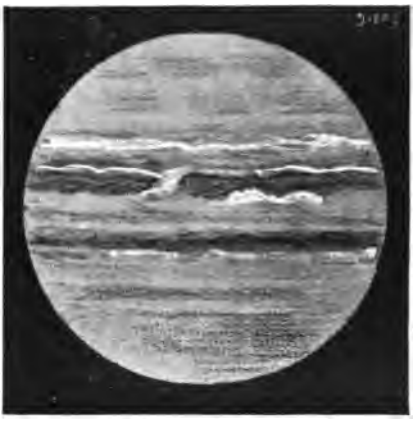

Fig. 16. J. Milton Offord, 12¼ in. Spec.
1898 June 21, 9 h. 10 m. Long. 322°.

Fig. 17. E. J. Cope, 8½ in. Spec.
1898, January 2, 19 h. 30 m. Long. 343°.

Fig. 18. T. E. R. Phillips, 9 in. Spec.
1898, March 29 10 h. 40 m. Long. 355°.

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Memoirs

OF THE

British Astronomical Association.

EDITED BY

E. WALTER MAUNDER, F.R.A.S.

REPORTS

OF THE

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SECTION FOR THE OBSERVATION

OF

METEORS.

DIRECTOR.—HENRY CORDER.

REPORT OF THE SECTION, 1898.

Introductory.

This year's report will be found to contain a fairly full account of the Perseid Shower, which was well observed in England, and also some interesting observations of the Leonids made in India. Beyond this, not very much has been accomplished in watching the showers, some being hidden by cloud, and others, as the Andromedes and Taurids failing to put in an appearance. There is also a valuable table of heights of meteor paths, contributed by Mr. Denning, whom we are glad to welcome again as a Member of the Association. The Section numbers about 12 Members, but from some not much has been received during the year, and the Director would wish, while thanking those who have contributed, to encourage those who have not, and also Members of the Association in general, to send in any stray observations of bright meteors of which the paths have been pretty accurately noted.

Bridgwater,
January 31, 1899.

HENRY CORDER,
Director.

Monthly Record of Meteor Showers.

JANUARY.

The Quadrantid shower was unobserved in England this year, but Mr. Backhouse, who was then voyaging on the Arabian Sea, had clear skies, and watched at intervals on the nights of January 1 and 2. It appears from a table of his observations, that only four Quadrantids out of a total of eight meteors, were seen in 49 minutes on January 1, and seven Quadrantids out of nine meteors in 58 minutes on January 2. Four of these were seen in 16 minutes shortly before midnight, giving an hourly rate (corrected for altitude of radiant) of 29 per hour. Two bright meteors were seen.

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FEBRUARY.

Mr. Besley mapped 16 meteors on the nights of February 20 and 22, a radiant in Bootes was probable. A few others were seen earlier in the month.

MARCH.

At the end of the month, Mr. Besley was again successful in mapping 14 meteors; a fairly strong radiant appeared in Draco, and another in Ursa.

APRIL.

The Lyrid shower was very poorly observed, and meteors were very scarce.

On April 19, Mr. Blakeley saw only six meteors in about 1½ hours, one being equal to Jupiter. The radiant seemed to be at about 268° + 36°, a good deal W. of the position mapped by Mr. Besley, and 10° N. of a position estimated by Mr. J. H. Bridger. So that it would seem that there were weak branch radiants active. Mr. Bridger only saw five meteors on this date between $9^h\ 45^m$ and $11^h\ 47^m$.

The night of April 20 seems to have been generally overcast. That of the 21st was finer, and Mr. Bridger saw six meteors in about $1^h\ 15^m$, and Mr. Besley saw the same number between $11^h\ 45^m$ and $13^h\ 30^m$.

On April 22, he tried again, watching from 12^h till $13^h\ 30^m$, and saw 14 meteors, of which eight were Lyrids. The radiant, rather diffused, was at about 273° + 33°.

At Bridgwater, a watch was kept on the 17th, but only one meteor was seen in half-an-hour, and on the 22nd, only one in 40 minutes. Both these watches were, however, before midnight.

MAY AND JUNE.

Almost no meteors were seen in these months, and none of the May Aquarids.

JULY.

Mr. Besley began watching for Perseids by July 14, when three of these meteors were seen from a radiant at 12° + 50°. Unfortunately observations were interrupted by a large conflagration in the neighbourhood, so that this is a rather uncertain position.

On July 20, four more were seen in $1\frac{1}{4}^h$, with a radiant at 21° + 51°; one more only in an hour's watch on July 24; but on the 28th, six were seen in an hour, with a radiant at 32° + 55°. These are an interesting addition to our knowledge of early radiants in this region, but may not all be connected with the August stream.

Mr. E. R. Blakeley says, that at Dewsbury, "the atmospheric "conditions were generally unfavourable, so that from July 26 "to August 19, only six nights were at all clear, and even then "haze prevailed round the horizon." July 27, only four meteors seen, one being probably a Perseid. At 11.30, a rather

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remarkable meteor was seen, which began as 1st mag., decreased to 4th, and vanished altogether twice during its flight, reappearing some degrees further on. July 29, clear during latter part of watch, and 22 meteors mapped between 11^h and 13^h 10^m, of which six were Perseids with a good radiant at $31° + 54°$. The finest meteor was at 12^h 10^m, and was estimated as brighter than Jupiter, and moved slowly in the S.E. heavens, near the horizon. On July 30, in a short watch, only two meteors were seen.

AUGUST.

The Perseid shower was very generally observed on August 11, as this was a night of exceptional clearness, and in some parts of the country, a partial view was obtained on August 10, but the other nights were more or less overcast.

Several Members of the Section have sent special reports which will be given almost in extenso, and the radiants deduced from them will appear in the general list for the year.

August 8, a few observations made by Messrs. Backhouse and Besley, the latter counted seven meteors in 25 minutes. On August 9, Mr. J. H. Bridger had a clear sky at Farnborough, and counted 12 meteors in an hour (10.0 to 11.0), of which 10 were Perseids.

On August 10, he also watched from 10.10 till 11.0, mapping 24 meteors, of which 17 were Perseids, and then continued watching without mapping until 11:30, when 28 more meteors were seen, and the hourly rate of Perseids rose to 48.

At Yeovil, the Rev. T. E. R. Phillips watched from shortly before 10.0 until 13.0, and recorded 40 meteors, of which 27 were in the last hour. A brilliant meteor was recorded at 12.2, and five others are spoken of as "bright," one at 12.5 being green.

At Portland, the Rev. W. R. Waugh saw 18 meteors between 9.30 and 11.0, of which 15 were Perseids, and five were of 1st mag., with bright streaks, one of a pinkish hue.

At Bridgwater, a tolerably continuous watch was kept between 9.30 and 12.45, when it clouded over; and before that, moonlight and clouds began to interfere. In all, 96 meteors were counted, of which 88 were Perseids. The hourly number for all meteors rose to about 40, in spite of moonlight. It would not be of any value to give a detailed table of the watch, nor of the magnitudes, as both results would be vitiated by the moonlight, but there were 15 reckoned as 1st mag., and eight brighter than 1st, of which the finest were at 10.40 and 12.0, both flashing out at the end of their course, and the former one left a spot of light for some seconds where the flash took place.

At Bridport, Rev. S. J. Johnson watched from 10.13 till 11.13, and counted 11 meteors, of which 10 were Perseids, the finest (at 12^h $1\frac{1}{2}^m$), which was of a greenish colour, being equal to Jupiter.

August 11, Mr. Johnson again watched for an hour, and counted 18 meteors between about 10^h–11^h. One of them, at 10^h $1\frac{1}{2}^m$, was equal to Venus at her greatest brilliancy.

At Cardiff, Mr. George Carslake-Thompson watched from about 9^h 30^m until 14^h 0^m, and saw 77 meteors. The largest number were seen in the quarter hour preceding midnight, when 18 were counted, and 52 in the whole hour, 12.45 to 13.45. Most of the

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meteors left phosphorescent streaks, and had bright heads, but those appearing near the radiant appeared to be almost all streak. The radiant was estimated to be at R.A. $2^h\,53^m + 55°\,40'$, but some came from nearer Cassiopeiæ. At Portland, Rev. W. R. Waugh noted eight meteors between 9.0 and 10.30, none occurring in the last half hour. (In this time, Mr. Thompson counted six, and the Director 11, after which the number more than doubled.)

At Dewsbury, Mr. Blakeley watched from $10^h\,20^m$ until $13^h\,40^m$ almost without intermission, and 52 meteors were seen, the Perseids being decidedly in the majority, with a radiant at 45 + 58 very diffuse.

The finest seen were at 10 32½ = Sirius; at 11 30 > ♃; at 12 1 = Sirius; at 12 23 = Sirius; at 12 25 = Sirius, and at 13 2 equal Jupiter. That seen at $11^h\,30$ was a typical Perseid of the brightest class, expanding at the end of its path with a lightning-like flash; the broad streak was of an intense golden colour, and the meteor appeared slightly deflected at the end of its course. A meteor appeared at 11 11, which seemed like a small faint nebulous cloud, moving slowly.

Mr. Blakeley has seen four or five others at various times with this appearance, and the Director also can corroborate the observation during his experience. Conditions can hardly have been so good at Dewsbury, as only about 15 meteors an hour seem to have been recorded.

At Exeter, on this date, Mr. Besley watched from $9^h\,15^m$ until $12^h\,40^m$, and counted 75 meteors, the rate per hour rising from 15 to 30. Of these, six Perseids and 11 other meteors were of 1st mag., three Perseids were brighter than 1st mag., but less than Jupiter, whilst one at $12^h\,24^m$, and a non-Perseid at $10^h\,15^m$ were as bright as Venus. The latter and another "erratic" were of a bluish colour. Mr. Besley considers that only 40 out of the 75 were Perseids, a good many being from Cassiopeia. No doubt some other observers would hardly note this distinction, and the Director is sorry to add that he among them did not map very many, and has perhaps "lumped" them as Perseids. A pretty good watch, however, was kept at Bridgwater. In the first place, one observer watching from $9^h\,15^m$ until $13^h\,30^m$, counted 149 meteors, of which 135 were counted as Perseids. The best hour was from 10.30 until 11.30, when 50 were seen. After this they fell off, partly on account of slight moonlight, to 33 an hour by the end of the watch, of which only 26 were Perseids. The most beautiful meteor seen was an Aquarid, at 8.58, details of which are given elsewhere. The magnitudes were as follows:—
> 1st, 12; 1st, 30; 2nd, 61; 3rd, 75; 4th, 31; 5th, 9; coloured 12.

No bright flashing Perseids were seen, and only two equal to Sirius. There was a rich orange 1st mag. near the radiant, and an interesting 3rd mag. with long streak directed from Taurus. Perhaps the Director is over cautious in the matter of magnitudes, or only unlucky, but it is well to describe conscientiously what is seen, and interesting then to compare the results with those of others. Another point seemed to be of interest: during part of the time two other observers were assisting, so as to cover as much sky as possible, and there seemed to be a considerable difference in the number of meteors seen in different parts of the

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sky. For instance, during an hour when Mr. Corder was watching the radiant and sky to E. of it, only 28 meteors were seen, whilst at the same time Miss M. L. Bayes, watching the western sky, counted 36, and Mr. T. B. Dilks had a similar experience watching in the direction of the Great Bear. So that it would seem that although the best estimate of the radiant is to be had by mapping the foreshortened meteors near it, yet more, with of course longer paths, are to be seen in other directions. These three observers also watched for an hour together. It should be stated that no part of the horizon was visible, and the view was a good deal shut in by trees and houses. Between 10.30 and 11.30 when the Director saw only 50 meteors, the three together counted 105, the best quarter-hour giving 29.

At Paignton, Mr. H. J. Townshend counted 50 meteors between 10.30 and 12 0, but some of the time was taken up in mapping. About six Cassiopeids were seen, and others thought to be from Hercules and Lyra. He considers that the hourly number between 10.30 and 11.30 was 60 meteors. The finest was seen at 9.19, and was estimated at twice the brightness of Venus, at the time when it broke out with a final flash. At 10.34 there was one as bright as Arcturus, with a red streak.

Mr. J. H. Bridger watched at Farnborough from 9.30 until 11.0 and 53 meteors were seen, the hourly rate when none were mapped between 10.30 and 11.0 being 60. Mr. Bridger was fortunate in observing the bright Aquarid mentioned above.

At Yeovil, Rev. T. E. R. Phillips, recorded 38 meteors between 9.40 and 11.56, and no doubt would have seen more but for time taken up by mapping.

At Aysgarth, Mr. J. E. Clark recorded 26 meteors in about an hour and a quarter, 10.0 to 11.15. Miss E. Brown also reports the shower as visible at Cirencester, and Mr. Backhouse saw a few at Seaton Carew. After this date very few were seen, and the weather was unfavourable.

SEPTEMBER.

As usual very few meteors were mapped in this month, which is not generally distinguished by strong showers, although those who diligently watch in the morning hours are often well repaid. Mr. Besley and Mr. Bridger both send notes of a few meteors, but not sufficient to deduce radiants from.

OCTOBER.

Mr. Besley recorded nearly 70 meteors in this month, chiefly on the 18th and 23rd.

On the 12th a few were seen, the chief radiant being in Aries.

The Orionids were active on the later dates, about 11 being put down to this shower, and six to that in Gemini, which is generally more or less contemporaneous. The Orion radiant was at 91° + 16°, about its usual position, indeed we always have found this one of the best defined and most stationary of all the chief meteor radiants, although the Geminids, which Mr. Besley places this year at 97° + 15°, and which are a much more diffuse system are often confounded with the true Orionids.

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The following table gives the general results of the watches kept at Westminster for the Orionid and contemporary showers :—

1898.	Watches.				Number of Meteors recorded.						
					Radiants.						
	From.	To.	Length.	Free from Cloud.	Taurus, 64°+ 14½°.	Orion, 91°+ 16°.	Gemini, 97°+ 15°.	Gemini, 107°+ 20°.	Telescopium, 115°+ 37½.	Others.	Totals.
	h. m	h. m.	h. m.	h. m							
Oct. 18	12 30	14 15	1 45	1 15	2	7	3	—	1	12	25
„ 23	12 15	12 45	0 30	0 30	—	—	—	1	—	3	4
„ 24	12 45	15 15	2 30	2 25	1	4	3	2	2	19	31
Totals -	—	—	4 45	4 10	3	11	6	3	3	34	60

Mr. Besley adds :—"The most brilliant meteor appeared at "13h 24m on October 18, and travelled swiftly from 87°—1° to "105°—10°. Its brightness was nearly equal to that of Venus, "its colour was bluish-white, and its head well defined. This "was an Arietid.

"Meteors of the 1st mag. were registered on the 18th at 12.57, "at 13h 12m (slow, orange), at 13h 52m (Orionid, bluish-white), "and on the 24th at 14h 47½m. The meteors from Taurus were "swift, the Orionids and Geminids also swift, and for the most "part left streaks."

NOVEMBER.

This was a month of disappointment and delusion, for clouds almost entirely hid the Leonids, and where clear very few were seen, and of the expected Andromedes none whatever appeared.

The Director has had many reports of the Leonids sent to him, for all which he hereby tenders his thanks, and will proceed to give a short summary of the more important ones, the rest being almost entirely a record of failure.

It may first be mentioned that the best view of the shower was evidently obtained in America, but even there it never reached the level of a great display, and elsewhere the Leonids hardly outnumbered the uncomformable meteors.

The most interesting record of the event has been sent by Mr. H. G. Tomkins, of Madras, who trained a number of educated native Indians to watch together, and although the resulting radiants are, perhaps, not very trustworthy, yet the details of the strength of the shower are valuable. Mr. Tomkins says :—"As I "have a house-top to work on, and a clear horizon all round, I "got together the party of 25 observers, chiefly from my office "here. They are educated men and soon took to it. They were "trained, as far as possible, by the aid of artificial showers made

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"with a magic-lantern, and also by studying the sky with their "maps for several nights beforehand. Some of them had some "knowledge of astronomy, and one had been trained in the "observatory.

"Seven cameras were set up, one a 4-in. lens, and one a magic-"lantern lens. Both these gave clear star trails, but unfortunately "caught no meteor. Another with a small wide-angle lens shows "the trail of Regulus, and a long path of a meteor very faintly, "showing a somewhat broken line, as if the light of the meteor "varied many times during its flight.

"The sky was under observation all the night, and every meteor "was counted. The parties worked in very good accord. The "counters were at a separate table, and the duration of flight of "the meteors was estimated by the aid of a pendulum, a man "keeping time on a box with a stick, as a metronome could not "be obtained; time was called every five minutes through the "three nights."

As far as possible other meteors than Leonids were excluded; during some of the watches they more than equalled the number of Leonids, but on the principal nights of the shower were of comparative rarity.

From November 7 to November 12, two separate observers were keeping watch between the hours of $13^h\ 30^m$ and $15^h\ 30^m$, and taking the most successful one, the results were of Leonids, in two hours, November 7th, 3; 8th, cloudy; 9th, 6; 10th, 21; 11th, 28; 12th, 28. On November 13 the combined watch began at 10.45, and 23 Leonids were seen in the first two hours, when it clouded over for three hours. At $15^h\ 45^m$ watching was resumed, and about 30 meteors were seen in an hour. On November 14 clouds obscured the sky until $13^h\ 25^m$, and only four Leonids appeared before 14^h. The numbers then run; to 15^h, 48 Leonids; to 16^h, 75; to 17^h, 79; to $17^h\ 20^m$, 42, when daylight became too strong.

The shower, however, evidently increased steadily, for in five minutes after $17^h\ 10^m$, 14 Leonids were seen. On November 15 it was clear all night, and even before midnight Leonids had begun to appear.

Beginning at $10^h\ 30^m$, the hourly numbers run,—15, 29, 41, 60, 81, 142, 74. The last number, however, does not represent a complete hour, as daylight came on about $17^h\ 20^m$. After this the combined watch was discontinued, but on the 16th, 38 Leonids were seen by one observer in two hours; on the 17th, 18 were seen; on the 18th, 15, with 24 from other radiants; on the 19th, 17 Leonids, and 12 others; on November 20th, 16 Leonids, and 14 other meteors. From these figures it appears that the maximum of the shower, as seen in India, was at 16^h on November 15, but that on the 14th also the earth was already deeply immersed in the meteor stream. It may be said that at the time of writing Mr. Tomkins was not a member of the British Astronomical Association, but was desirous of joining the Association, and the thanks of the Meteor Section are all the more due to him for his kindness in sending his most interesting results,

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and for the careful way in which he carried out his plans, which most fortunately were but little interfered with by the weather. Mr. Tomkins also sends maps of meteor tracks made by an Indian gentleman, near Trichinopoly, who observed a large number of Leonids and other meteors. The radiants do not come out very clearly, and the Director again wishes to impress on observers the absolute necessity of watching with a rod in the hand, to hold up immediately along the line of flight, and also in mapping, at once to carry back the line to some distant star, if possible near to or beyond the supposed radiant. Only one brilliant meteor appeared, which unfortunately ended with a bright flash behind a cloud.

On November 12 a watch was kept at Bridgwater, from $14^h\ 35^m$, until daybreak at about $17^h\ 10^m$, and 27 meteors were seen, but only about six were Leonids. The finest meteors came from the direction of Taurus and apparently belonged to at least two radiants, but not more than one or two could have been of the usual Taurid shower.

Mr. Backhouse made a number of short watches, but did not see many meteors. His chief watch was in the twilight of November 13, when one meteor was thought to be a Leonid. The next two mornings were overcast. Mr. W. J. Hall was watching on the same morning, and also found meteors very scarce; only two meteors seen in about an hour, and neither of them a Leonid.

Mr. Pope, at Dingwall, had the morning of the 16th clear, and saw about a dozen meteors, of which about eight were Leonids. These were seen between 3^h and 4^h a.m.

Mr. J. H. Bridger, at Farnham, on November 13, watched from $14^h\ 5^m$ till $17^h\ 20^m$ and saw 11 meteors, of which seven were Leonids with a radiant of $150° + 22°$. One meteor as bright as Sirius, seemed to explode at $15^h\ 26^m$.

Mr. Besley was disappointed altogether, as were also Mr. Blakeley and Mr. Townshend. Mr. H. Pain, at Cambridge, sends notes referring to each night, chiefly describing the varying density of the clouds until November 14, at $16^h\ 35^m$, a bright flash was seen. After this, although hazy clouds almost entirely hid the stars, eight meteors were seen before $17^h\ 30^m$, chiefly in the S., as the observations were made from a window. Mr. G. B. Longstaff and others, at Wimbledon, succeeded in seeing two rather bright meteors on November 14, that at 10.20 being brighter than Mars, and travelling about 120°.

On November 13, Mr. W. M. Worssell, observing from the Esplanade, Bognor, saw a fair number of meteors between 12.30 and $17^h\ 45^m$ in a clear sky, but the rest of the reports received are of total failure.

The Andromedes never came at all, although a great shower was expected. It was, indeed, moonlight at the time, but on many evenings during the week stars were fairly bright, but no one seems to have recorded a single meteor, and up to the time of writing nothing has been heard of any foreign observation of the shower. Although the weather accounts for most of the failures

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in November, yet there were times when the sky was clear, and it should therefore be noted that, with one or two possible exceptions, no Taurids were recorded during the month, and it can hardly be doubted but that the shower was very weak this year.

DECEMBER.

The Geminid epoch was almost as overcast as the Leonid, but Mr. Besley succeeded in making a good observation on December 9, and again on December 12. There appeared to be three radiants in Gemini, the chief one at 115° + 32°, another at 104° + 31°, and the third at 108½° + 28°. This only produced three meteors, but from their different character it may be considered that they belonged to the shower of long streak-leaving meteors seen in former years, but lost for some long time. Only about 10 meteors per hour were recorded on the 12th, and a less number on the 9th. One Geminid was as bright as Jupiter. There appeared to be radiants also in Monoceros, Auriga, and Cancer. Mr. T. H. Astbury sends a list of meteors, one of them, a 1st mag., being stationary 1° N.W. of Castor at 8.29 on December 9, and, no doubt, fixing the radiant of the Geminids pretty nearly. Mr. J. H. Bridger watched from 9 till 11 on December 9, and saw 10 meteors, of which only one or two could have been Geminids. The strongest radiant seemed to be in Ursa Major at 122° + 41°. Mr. T. W. Backhouse made the most complete series of observations at the Geminid epoch, but did not record any until December 7, when one was seen. On December 11, in 83^{m} before midnight, nine meteors were seen, of which six were Geminids; but the sky was covered with thin cloud. On December 12, in 125^{m} between 7 o'clock and 13^{h} 22^{m}, 25 meteors were seen, 19 being Geminids. The hourly rate for all meteors rose to about 19 after midnight. Two more Geminids were seen on the 13th, but none on the 14th. One meteor at 12.29 on December 12 was equal to Venus, and brilliantly coloured.

At Bridgwater, watches of short duration were made on December 7 (no meteors), December 12 (one Geminid), December 15 (four meteors, of which one was a Geminid). On December 19, Mr. Besley recorded 20 more meteors, with radiants in Leo, Ursa, and Draco. The last-named seemed a very active shower, with a radiant at 197½° + 69°, seven meteors, of which two were brighter than 1st mag.

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Radiants of Meteor Showers, 1898.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1898.		° °			
790	Feb. 20–22	Bootes	215 + 33	4	Quick	W. E. B.
791	Mar. 29–31	Ursa Major	178 + 57½	4	Quick	W. E. B.
792	„ „	Draco	245 + 55	6	Swift	W. E. B.
793	Apr. 19	Lyrids	268 + 36	4	Swift	R. R. B.
794	„ 19–21	„	268 + 25	5	Swift	J. H. B.
795	„ 21–22	„	273½ + 32½	12	Swift	W. E. B.
796	July 14	Perseids	12 + 50	3	Swift	W. E. B.
797	„ 20	„	21 + 51	3	Swift	W. E. B.
798	„ 28	„	32 + 55	4	Swift	W. E. B.
799	„ 29	„	31 + 54	5	Swift	E. R. B.
800	Aug. 8	„	42 + 57	3	Swift	W. E. B.
801	„ 9	„	42 + 55½	10	Swift	J. H. B.
802	„ 10	„	43 + 55½	16	Swift	J. H. B.
803	„ 10	„	43 + 59	11	Swift	H. C.
804	„ 10	„	45 + 55	—	Swift	T. E. R. P.
805	„ 10	„	43 + 53	—	Swift	J. H. T.
806	„ 11	„	45 + 58	40	Swift	W. E. B.
807	„ 11	„	45 + 56	13	Swift	J. H. B.
808	„ 11	„	49 + 58	13	Swift	H. C.
809	„ 11	„	46 + 58	—	Swift	T. E. R. P.
810	„ 11	„	46 + 56	29	Swift	J. H. T.
811	„ 11	„	45 + 58	30	Swift	E. R. B.
812	July 29	Polarids	5 + 88	6	Quick	E. R. B.
813	Aug. 9	Cepheids	323 + 65	3	Quick	J. H. B.
814	„ 11	Cassiopeids	2 + 50	11	Swift	W. E. B.
815	Aug.	Camelids	67 + 55	4	Swift	J. H. B.
816	„ 11	„	70 + 65	4	Swift	T. E. R. P.
817	„ 11	θ Aquarii	328 + 6	7	Slowish	E. R. B.
818	„ 11	δ Equulei	317 + 10	6	Quick	E. R. B.
819	„ 11	Piscids	348 + 3	5	Slowish	J. E. C.
820	„ 11	„	350 + 5	2	Slowish	H. C.
821	„ 17	Pegasids	345 + 15	4	Quick	E. R. B.
822	„ 17	Honorids	347 + 51	4	Quick	E. R. B.
823	Sept. 9	Perseids	47 + 39	4	Swift	W. E. B.
824	Oct. 12	Arietids	43½ + 16½	4	Slow	W. E. B.
825	„ 18–24	Muscids	43 + 22	3	Slow	W. E. B.
826	„ „	Taurus	64½ + 12½	4	Slow	W. E. B.

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B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1898.					
827	Oct. 18–24	Orionids	91° + 16°	7	Swift	W. E. B.
828	„ „	γ Geminids	97 + 15	3	Swift	W. E. B.
829	„ „	δ Geminids	107 + 20	3	Swift	W. E. B.
830	„ „	Telescopium	115 + 37½	5	Swift	W. E. B.
831	Nov. 14	Leonids	153 + 20	—	Swift	Indian.
832	„ 14	„	148 + 21	—	Swift	Indian.
833	„ 15	„	148 + 24	—	Swift	Indian.
834	„ 15	„	148 + 24	—	Swift	Indian.
835	„ 16	„	154 + 20	5	Swift	J.T. Pope.
836	„ 12	„	144 + 27	4	Swift	H. C.
837	„ 13	„	150 + 22	7	Swift	J. H. B.
838	„ 13	Ursa Major	151 + 66	4	Quick	H. C.
839	„ 13	ζ Tauri	83 + 24	5	Slow	H. C.
840	„ 13	o Tauri	52 + 5	5	Slow	H. C.
841	„ 13	β Cancri	123 + 14	2	Quick	H. C.
842	„ 14	„	122 + 9	—	Quick	Indian.
843	Dec. 12	Cancer	130 + 20	5	Quick	W. E. B.
844	„ 12	Auriga	71½ + 47	3	Swift	W. E. B.
845	„ 9–12	Monoceros	99½ − 5½	4	Swift	W. E. B.
846	„ „	Gemini	108½ + 28	3	Swift	W. E. B.
847	„ „	Geminids	104 + 31	7	Quick	W. E. B.
848	„ „	„	115 + 32	11	Quick	W. E. B.
849	„ 9	Ursa	122 + 41	4	Swift	J. H. B.
850	„ 19	Ursa	174½ + 58½	4	Swift	W. E. B.
851	„ 19	Leo	151½ + 26½	3	Swift	W. E. B.
852	„ 19	Draco	197½ + 69	7	Swift	W. E. B.

Doubly observed Meteors, 1898.

FIREBALL OF JANUARY 21d 5h 32m.

This was, perhaps, the most interesting meteor of the year, and a great many accounts were received, either by letter or newspaper cuttings. Mr. Denning used 33 in his calculation of its path, so it was evidently very generally observed in the south of England at any rate. The real path was such a long one, and was prolonged so far over the English Channel that it is difficult to say where the real end-point was, for it is evident that many observers only saw the earlier part of its flight, not many noticing the explosion which occurred towards the end. The height at first appearance was 82 miles over Croydon, after which it traversed the very long path of 235 miles at a rate of 34 miles

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per second, and ended over the Channel at a height of 25 miles. The radiant was at 130° + 30° in Cancer. Mr. Denning compares this with the path of a fireball of January 19, 1877, at $6^h\ 27^m$, the length of path, velocity and radiant agreeing almost exactly.

In colour the meteor is very variously described. Perhaps the following description shows the sequence of the changes:—At commencement reddish, then yellow or golden, turning to electric blue, and then green, when it burst into a number of yellow fragments. It seems to have been accompanied by a train. Of course, the apparent size varied very much at different distances. At Catford it appeared of the size of Venus, but from Torquay, much nearer the end of the path, it appeared of the "perfect "shape and size of the full moon, when it suddenly changed to "the shape of a pear (stalk foremost), then burst. A stream of "light gushed out, preceded by a row of stars of vivid coloured "brilliancy, and the whole together at the same speed vanished "into space."

GREAT FIREBALL OF JANUARY 26. (*Communicated by Mr. Walter F. Gale*).

A fireball of unusual magnificence appeared at $10^h\ 6^m$ on the night of January 26. At this time I was standing with others on the bridge at the entrance to Lake Macquarie looking northward up the channel, and watching the innumerable fish faintly outlined in the phosphorescent water. Suddenly the whole scene was brilliantly illuminated, two small vessels and the trees a quarter of a mile distant showing out clearly. The fish simultaneously darted in all directions, many hundreds of mullet, taylor, and perch making clean breaches from the water. Several members of the party exclaimed "lightning," and such was my own first impression. The moon was absent from the sky, and I knew it was absolutely cloudless to the horizon, so instinctively turned to the south-east.

Immediately above δ Centauri, moving northwards, was a mass of intensely bright green light, estimated at 18′ × 12′, with several small detached fragments of a ruddy colour. The path it had traversed was still glowing, and extended back to the Cross. The motion of the meteor was slow, carrying it over ζ Hydræ to a point preceding δ Crateris. I fixed the beginning and end points of the track seen by me as R.A. $11^h\ 58^m$ — 50° and R.A. $11^h\ 5^m$ — 14°, and the period occupied in traversing it three seconds. No detonation was heard. A Mr. Drew, who saw the first outburst of the fireball, pointed out to me at the time the star ι Hydri as near the origin of its visibility. He was certain the point was between the Magellanic clouds, and as nearly as I could fix it at R.A. $3^h\ 20^m$ — 78°. It rapidly blazed out, and seemed to him as large as the moon, but much more brilliant.

I have failed to obtain intelligible tracks from those who saw the meteor from Newcastle, but trust an observer to the south of our station will furnish useful particulars.

METEOR OF FEBRUARY 20, $8^h\ 54^m$.

A large number of observations of this meteor came to hand, some of them from our own Members. Mr. Besley saw it, and

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rated it as brighter than Venus, and of a bluish-white colour, moving swiftly. Unfortunately there seems to have been more confusion about this meteor than is usually the case, and Mr. Denning says that he spent several whole days trying to unravel the mystery. It is always possible that more than one meteor may have been seen, and on this occasion Mr. Besley's path does not agree with most of the others, and Mr. Ryle, who writes from Brighton gives the date as Monday, February 21. In other respects it agrees with the other observations. His meteor somewhat exceeded Venus in brilliancy, and was of a yellowish white. The path ultimately decided on by Mr. Denning was 95 miles in length, performed at the rate of 24 miles per second, from a height of 61 miles to one of 24 miles over the English Channel. The radiant was near β Leonis.

METEOR OF APRIL 5, $10^h\ 15^m$.

The following account was furnished by the Rev. T. E. R. Phillips:—"I was fortunate enough to see a splendid meteor on "April 5 at $10^h\ 15^m$. It was simply magnificent, in spite of the "moonlight, and travelled visibly over a path exceeding 100° of "longitude. The moonlight, and consequent paucity of bright "stars, made it somewhat difficult to determine its track with "accuracy, but I think the following particulars are not far off "the mark. Time occupied in traversing its apparent path, "12 to 15 seconds. Colour, golden yellow or orange. Magnitude "about equal to Venus. Estimated track from 154° + 17° to "260° + 22°. The meteor left a train of sparks behind it. "I should say that I probably missed its first appearance, but "it arrested my attention when observing Jupiter, by the brilliant "light it caused in the sky. I also lost its final disappearance, as "it dropped behind some houses, and so was lost to view, though "fast fading at the time." Mr. Denning received other observations of this fine object, and it will be seen, by referring to his table, that it was a Monocerotid, with a radiant at 121°—1°, and during a visible path of 162 miles, traversed at a speed of about 11 miles per second (the slowest of any in the list, it may be noted), it fell from a height of 89 miles over a point 25 miles S.E. of Dartmouth to a height of 25 miles over a point five miles N.E. of Bisley.

AQUARID METEOR OF AUGUST 11, $8^h\ 58^m$.

This beautiful meteor was seen by many in the twilight of August 11, just as the Perseids were beginning to appear. It belonged, however, to the well-known shower of Aquarids, with a radiant at 339°—10°. It was estimated as equal to Jupiter or Venus in brilliance, and had a long, almost horizontal path, as seen by most English observers, as it travelled from a height of 66 miles over the River Seine to a height of 41 miles over Okehampton, a distance of 196 miles at a somewhat slow rate. Reports were received from Mr. W. J. Stanton, of Stroud, who noted that the train was bright at the latter part of its course, and that it lasted several seconds; from Mr. E. W. Johnson, of Croydon, who says that it travelled from S.E. to S.W. passing

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just below Saturn; and from Mr. F. W. Levander, in London, who noticed, as others did, that a number of sparks were given off near the end, but did not consider that any streak was left. It was well seen at Bridgwater, and as this was nearer the end point, the "sparks" appeared more brilliant and took the form of small balls of fire given off one after another, until towards extinction, there were, perhaps, four, inclusive of the head, forming a train of white bodies followed by a reddish train or streak, which extended for a distance of about 4° behind the meteor. Mr. T. H. Astbury gives the duration as four seconds, and states that there were five or six fragments dying away one after another.

METEOR OF AUGUST 19, 10^h (local time).

A fine meteor, seen by Rev. T. H. Foulkes from S.S. "Malacca," off Algiers. The meteor was seen on the confines of Aries and Taurus, and was of all colours, chiefly scarlet and orange, not very swift, but with a "powerful" motion. Train short, and general shape like an Indian club. The moment it vanished, close to the horizon a double flash of sheet lightning appeared exactly under the vanishing point of the meteor. As no other flashes were seen during the evening, Mr. Foulkes conjectures that they may have been connected with the meteor, which seems highly probable.

METEOR OF OCTOBER 4, 6.25 (Calcutta time, $5^h\ 53^m$ E.).

Mr. J. W. Meares reports this meteor from his own observation, and also that of others who saw it, and it may be interesting to give the accounts pretty much *in extenso*. Mr. Meares says that "daylight prevented the path being noted properly, but it is "roughly, as follows. Started in R.A., $18^h\ 20^m$, Dec. — 5°, "ended by disappearing behind a house at an altitude about "5° lower. Path nearly 60° in about 3½ seconds, very slow "indeed. Colour dull orange, about 1st mag. at first, increasing "until it had a sensible diameter of nearly ¼°, and of a brilliant "white, casting a strong shadow even in the daylight. A train "of sparks was visible some few seconds after disappearance." Mr. H. J. Bell saw it at Chandbali, Orissa (some 160 miles from Mr. Meares' station), and says it seemed to pass almost directly overhead and disappear in the E. A lady in Dacca estimated the time at five or six seconds, and it was travelling S.E. Mr. W. S. Adie, at Berhampore, near Moorshedabad, writes, that it began a little E. of S., and finished a little S. of S.E., travelling horizontally at an altitude of 10°. Among other accounts, Rev. E. G. Roberts, Masulipatam, about 620 miles S.W. from Calcutta, reports that it was seen there, but from its greater distance did not appear brighter than Venus on a dark sky, and was of a vivid blue. These are chiefly of interest to show the long distances over which large meteors are visible, for the details are hardly sufficient to decide on a path for it.

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REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1898. *Contributed by* W. F. DENNING.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1898.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Jan. 21	5 32	½=☽	82	25	255	34	Croydon, Surrey	English Channel	133 + 30	*Cancrid*	33 observers.
Feb. 20	8 54	>♀	61	27	95	24	33 miles S. of Beachy Head.	13 miles S.E. of St. Albans Head.	176 + 12	*β Leonid*	18 observers.
April 5	10 15	2×♀	89	25	162	11	25 miles S.E. of Dartmouth.	5 miles N.E. of Bisley.	121 − 1	*Monocerotid.*	5 observers.
„ 16	9 46	3—1½	72	55	52	Slowish	8 miles E. of Nottingham.	7 miles E. of Glossop	212 − 11	*Librid*	A. S. H.; A. K.
„ 16	10 48	Sirius—1½	60	48	91	24	Halstead, Essex	North Sea	189 − 31	*β Hydrid*	A. S. H.; A. K.
„ 17	9 40	2½—1	85	71	81	41	Stafford	Bridgnorth	261 + 14	*αOphiuchid*	A. S. H.; A. K.
„ 17	9 55	4—3	57	55	24	Slow	Chesham	Bicester	236 − 13	*ψ Scorpid*	A. S. H.; A. K.
„ 17	10 28	5—3	72	70	34	23	Malmesbury	Evesham	176 − 35	*β Hydrid*	A. S. H.; W. F. D.
„ 17	11 12	3—2½	67	44	24	Slow	Stroud	Gloucester	195 + 40	*α Canes Venaticid.*	A. K.; W. F. D.
„ 17	11 28	2	65	61	25	36	Amesbury	Burton	291 + 13	*ε Sagittid*	A. S. H.; A. K.; W. F. D.
„ 18	11 55	2—1½	65	58	19	32	Pontypool	Merthyr	274 + 11	—	A. S. H.; W. F. D.
„ 22	10 30	5—4	72	52	26	Slow	Alcester	Malvern	252 + 49	*β Draconid*	A. K.; W. F. D.
July 16	11 42	2>1	79	37	46	21	Thrapston	Bedford	273 + 76	*ψ Draconid*	A. K.; W. F. D.
„ 26	9 10	½=☽	73	27	191	Slow	25 miles W. of Dieppe.	March, Cambs.	269 − 23	*Sagittarid*	Dennett, Grover, &c.
„ 30	10 43	1—2½	81	47	57	36	Northampton	Burford	23 + 53	*Perseid*	A. S. H.; W. F. D.
„ 30	10 53	4—3½	61	52	20	14	Witney	Shipston	311 − 10	*μ Aquarid*	A. S. H.; W. F. D.
„ 30	11 10	3½—3	56	50	28	20	Chipping Norton	Alcester	340 − 18	*δ Aquarid*	A. S. H.; W. F. D.
„ 30	11 35½	3—1	66	52	63	45	Littleport, Cambs.	Blakesley	42 + 23	*ε Aristid*	A. S. H.; W. F. D.
Aug. 11	8 58	2½—♀	66	41	196	Slow	River Seine, France	Okehampton	339 − 10	*δ Aquarid*	H. C.; W. F. D., &c.
„ 11	10 15½	2½—♀	92	68	45	Swift	Aberdovey	Cardigan	44 + 56	*Perseid*	Five observers.

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REAL PATHS OF FIREBALLS AND SHOOTING STARS, &c., 1898—*continued.*

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1898.	h m		Miles.	Miles.	Miles.	Miles.			α° $\delta_\circ$		
Aug. 11	10 26½	2½—2	86	61	45	58	Shiffnal - -	Leominster - -	46 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	10 46	2½—2½	79	65	23	46	12 miles W. of Brecon.	Swansea - -	46 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	11 11½	1>1	85	49	57	Swift	Redditch - -	Monmouth - -	44 + 56	*Perseid*	W. E. B.; W. F. D.
„ 11	11 52	2—1½	55	49	53	27	Oakham - -	Chesterfield - -	4 − 20	*β Cetid*	A. K.; W. F. D.
„ 11	11 57	3—2	56	39	25	36	Winchester - -	Fareham - -	57 + 73	*Camelid*	A. S. H.; A. K.
„ 11	12 6½	1	86	46	59	Swift	Kingston - -	Selborne - -	46 + 58	*Perseid*	S. J. J.; T. E. R. P.
„ 11	12 16½	1½—1	74	50	33	Swift	Watlington - -	Hermitage - -	50 + 63	*Perseid*	A. S. H.; W. F. D.
„ 11	12 20	1½—1	64	48	24	37	Cirencester - -	Chipping Sodbury -	54 + 56	*Perseid*	A. S. H.; W. F. D.
„ 11	12 24½	>1—2½	78	52	36	38	Alton, Hants -	Southampton -	49 + 59	*Perseid*	A. S. H.; W. F. D.
„ 11	12 40	2½—1	85	60	32	31	Chichester - -	Ryde, Isle of Wight	43 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	12 46½	3—2½	75	59	21	Swift	Oxford - -	Abingdon - -	59 + 63	*Camelid*	A. S. H.; W. F. D.
„ 17	11 43	2—1	71	55	32	43	10 miles N. of Slough	Basingstoke -	72 + 52½	*Aurigid*	A. S. H.; W. F. D.
„ 21	9 16	1½ × ♀	60	29	95	19	15 miles S.E. of Cressy, France.	36 miles S. of Brighton.	5 + 13	*γ Pegasid*	A. S. H.; A. R. Schulz.
Sept. 15	8 17	1—2½	69	61	58	39	Thame, Oxon. -	Salisbury - -	65 + 35	*ε Perseid*	Col. Herschel; W. F. D.
„ 16	10 55½	>2—1	82	55	39	Swift	Devizes - -	Stroud - -	351 + 7	*θ Piscid*	A. K.; W. F. D.
„ 17	11 40½	1—2½	95	64	93	—	Strait of Dover -	Woolwich - -	57 + 7	*ε Taurid*	A. S. H.; A. K.
„ 17	11 52	4½—1	64	52	19	19	Northampton -	Market Harboro' -	343 ± 0	*β Piscid*	A. S. H.; A. K.
„ 18	8 54	>2½	69	46	104	Swift	Minehead - -	20 miles S.E. of Falmouth.	84 + 41	*β Aurigid*	T. E. R, P. and others.
„ 22	9 13	3—1	107	82	34	V. slow	Harleston - -	10 miles S.E. of Lowestoft.	254 + 39	*π Herculid*	A. K.; W. F. D.

Abbreviations:—A. S. H., A. S. Herschell, Slough; A. K., A. King, Leicester; W. F. D., W. F. Denning, Bristol.

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BRIGHT METEORS OBSERVED DURING 1897.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Jan. 1 -	12 14 34	Sirius	Beautiful. Appeared at l^2 Virginis, passed 15 Sextantis. Disappeared near ι Hydræ, moderately quick. Duration, 2·9 secs. Faded gradually. Bright streak or train along about 10° of its course at a time.—T. W. B., Arabian Sea.
„ 2 -	11 41 16	Venus	Very beautiful, passed, or directed from $\frac{1}{2}$ (p q) Velæ, towards $\frac{1}{2}$ (δ o) Arg. Disappeared about 4° before that; course about 15°. Quick. When brightest, was bright yellowish green, which was shortly before disappearance. Bright greenish streak.—T. W. B., Arabian Sea.
„ 21 -	5 31 0	$\frac{1}{2}$ ☾	(*See* special account.)
„ 26 -	10 6 0	= ☾	(*See* special account.)
Feb. 20 -	8 54 0	> ♀	From 111° + 5° to 97° − 17°. Bluish white, swift.—W. E. B. (*See* special account.)
„ 21 -	9 10 0	> ♀	From 10h. 18m. + 17°·5 to 7h. 18m. + 35°. Duration 3 or 4 secs. Bluish white. Train of 4°.—EVAN REES, Stockton.
Mar. 6 -	10 0 0	2	Passed slowly from 8h. 20m. + 29° to 7h. 42m. + 35°. White, with short train.—EVAN REES, Stockton.
„ 14 -	12 4 0	>1	From 86° + 33½° to 76° + 32° very slow.
Apr. 5 -	10 15 0	♀	(*See* special account.)
„ 19 -	10 50 0	2	From 252° + 23° to 242° + 19°. Slow. Colour, bluish white.—E. R. B.
July 14 -	8 16 0	> ♀	From near ϵ Delphini towards lower part of Pegasus, passing out of sight behind building. 10° of path seen. Very slow. Colour yellowish white, no train. —R. J. RYLE, M.D., Brighton.
„ 29 -	12 10 0	> 2	From 346° + 5° to 333° − 6°. Slow. Orange yellow. Near limit of vision.—E. R. B.
„ 31 -	10 21 0	2	About 30° S.E. of Moon, directed from Altair. Red. Short train.—H. J. T., Paignton.
„ 30 -	10 43 0	2	From 15° + 54° to 4° + 54½°. Very slow. Streak, near its radiant, an early Perseid.—W. F. D.
Aug. 3 -	9 58 0	2	From 15° + 43° to 25° + 22°. Duration 1 sec. Red streak.—H. J. T., Paignton.
„ 3 -	10 38 0	Capella	From 51° + 51° to 57° + 48°. Duration 1 sec. Blue streak.—H. J. T.
„ 6 -	10 30 0	2	From 307° + 13° to 299° − 1°. Burst out as a flash of light. Duration 1 sec.—H. J. T.
„ 8 -	9 41 0	>1	From 355° + 46° to 334° + 30°. Swift. Streak.—W. E. B., Exeter.
„ 9 -	9 37 0	2	Directed from δ Ursæ Majoris, towards ½° s.p. η Bootis, disappeared 1° before that. Course seen 6°. Very quick, 3 secs. Streak or train.—T. W. B.
„ 10 -	10 36 0	Sirius	From 328° + 60° to 302° + 46°. Swift, streak.—H. C.
„ 10 -	10 40 0	2	From 333° + 35° to 315° + 10°. Long streak, flash at end, leaving spot for some seconds.—H. C.
„ 10 -	10 41 0	Bright	From 325° + 67° to 279½° + 42°.—T. E. R. P.
„ 10 -	10 43 0	>1	From 246° + 62° to 242° + 46°. Quick, streak.—H. C.
„ 10 -	10 50 0	2	Directed from 2 (γ η) Persei towards α Andromedæ, disappeared about Dec. + 45°. Course, 6° or 7°. Moderate speed.—T. W. B.

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Date.	Time.	Mag.	Remarks.
1898.	h m s		
Aug. 10 -	10 50 2	Sirius	Directed from α Pegasi, disappeared about ½ (γ Pegasi, α Andromedæ). Course 10°. Moderate.—T. W. B.
„ 10 -	10 51 0	>1	From 75° + 63° to 80° + 63°. Yellow. Swift, streak.—H. C.
„ 10 -	11 25 0	>1	From 360° + 18° to 349° + 2°. Orange. Streak.—H. C.
„ 10 -	11 59 0	Bright	From 343° + 28° to 330° + 83°.—T. E. R. P.
„ 10 -	12 0 0	½	From 30° + 69° to 20° + 75°. Bright flash and streak.—H. C.
„ 10 -	12 1 30	½	From near γ Cephei to a point below Polaris. Greenish.—S. J. J.
„ 10 -	12 2 0	½?	From 35½° + 65° to 215° + 77°. Large, bright.—T. E. R. P.
„ 10 -	12 5 0	Bright	From 187½° + 54° to 177½° + 46°. Green.—T. E. R. P.
„ 10 -	12 5 0	>1	From 247° + 43° to 247° + 30°. Fine. Orange, streak.—H. C.
„ 10 -	12 6 0	1	From a point 1° N. of β Persei to 8° towards S.W.—S. J. J.
„ 10 -	12 6 0	—	From 11¼° + 28° to 354¼° + 12°.—T. E. R. P.
„ 10 -	12 7 0	—	From 38¼° + 47° to 32¼° + 32°.—T. E. R. P.
„ 10 -	12 8 0	>1	From 290° + 52° to 275° + 38°. Orange. Streak.—H. C.
„ 10 -	12 24 0	Bright	From 60° + 60½° to 72° + 62°.—T. E. R. P.
„ 10 -	12 52 0	Bright	From 334¼° + 70° to 265° + 55½°.—T. E. R. P.
„ 11 -	8 58 0	>♀	(*See* special account.)
„ 11 -	9 18 0	>1	From 353° + 38° to 343° + 27°. Red. Swift. Streak.—H. C.
„ 11 -	9 19 0	2×♀	From 95° + 70° to 157° + 59°. Very fine. Blue flash and streak.—H. J. T., Paignton.
„ 11 -	10 1 30	♀	From 5° E. of γ Ursæ Majoris passed over χ and disappeared 1° further.—S. J. J.
„ 11 -	10 14 0	½	Directed from near ϕ^2 Andromedæ and γ Persei. Disappeared near β Andromedæ. Slowish from nearness to radiant.—T. W. B., Seaton Carew.
„ 11 -	10 15 0	♀	From 140° + 72½° to 165° + 64°. Swift, streak.—W. E. B., Exeter.
„ 11 -	10 16 0	½	From 200° + 61½° to 206° + 44½°. Rapid with streak and flash. Perseid.—W. F. D.
„ 11 -	10 17 0	Very bright.	From 160° + 71° to 189½° + 45½°.—T. E. R. P.
„ 11 -	10 17 0	Sirius	From 165° + 73° to 184° + 54°. Yellow. Swift. Streak.—H. C.
„ 11 -	10 17 15	1	Commenced ½° above α Ursa Majoris, vanishing at γ.—S. J. J.
„ 11 -	10 32 30	Sirius	From 342° + 40° to 345° + 13°. Swift. White, not α Perseid.—E. R. B.
„ 11 -	10 34 0	Arcturus	From 98° + 56° to 117°+51°. Wavy path. Red streak.—H. J. T.
„ 11 -	10 34 15	1	From ψ Ursæ, and travelled 12° diagonally towards W. horizon.—S. J. J.
„ 11 -	10 45 0	½	From 240½° + 62½° to 237° + 47°. Very rapid. Streak. Perseid.—W. F. D.
„ 11 -	10 48 30	>1	From 52°+55° to 55°+53°. Swift. Streak.—W. E. B.

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Date.	Time.	Mag.	Remarks.
1898.	h m s		
Aug. 11 -	10 57 0	>1	From 21°+26° to 16°+11½°. Rapid. Streak. Perseid. —W. F. D.
„ 11 -	11 27 0	Bright	From 328½° + 65½° to 276½° + 34½°.—T. E. R. P.
„ 11 -	11 31 15	>½	From 345° + 51° to 323° + 41°. Swift. Golden, flashing at end and perhaps deflected.—E. R. B.
„ 11 -	11 50 0	Sirius	From 187° + 53° to 200° + 71°. Swift. Streak.—H. C.
„ 11 -	11 58 0	1	From 6° + 23° to 359° + 10°. Orange. Streak.—H. C.
„ 11 -	12 1 0	Sirius	From 17°+69° to 347°+71°. Slowish. Orange. Bright streak. ? Camelid.—E. R. B.
„ 11 -	12 23 0	Sirius	From 37° + 14° to 37° + 7°. Swift. White.—E. R. B.
„ 11 -	12 23 30	½	From 14½°+ 29° to 6° + 16°. Rapid. Flash. Streak. Perseid.—W. F. D.
„ 11 -	12 24 0	0	From 57½° + 55° to 67° + 50°. Swift. Bluish. Streak. —W. E. B.
„ 11 -	12 24 0	1	From 185°+73° to 195°+62°.—H. C.
„ 11 -	12 25 0	Sirius	From 331°+32° to 331½°+ 39°. Swift. White. Golden streak.—E. R. B.
„ 11 -	12 27 0	1	From 40° + 62½° to 37° + 66°. Orange. Narrow green streak, near radiant. H. C.
„ 11 -	13 2 0	½	From 350° +.76° to 380° + 73°. Very swift. White.— E. R. B.
„ 11 -	13 11 0	½	From 20½° + 1° to 18° + 11°. Rapid, flash, streak. Perseid.—W. F. D.
Sept. 3 -	7 3 0	2×0	Seen in twilight and path estimated from 6° + 53° to 32° + 58°. Slow. 2 secs. White, no train.— T. H. ASTBURY, Wallingford.
„ 15 -	8 18 0	½	From 11° + 39° to 333° + 26°. Slowish, bright streak. Radiant, 61° + 36°.—W. F. D.
„ 15 -	8 56 0	Sirius	From 17h. 30m. + 40° to 17h. 10m. + 17°. Quick. 2 secs. Yellow, with narrow streak. — J. M. WADMORE, Exmouth.
Oct. 3 -	6 15 0	0	From about 40° above S. horizon, fell 15° towards S.W. —G. T. DAVIS, Reading.
„ 18 -	13 24 0	0	From 87° − 1° to 105° − 10°. Bluish white. Swift. Arietid.—W. E. B.
„ 31 -	8 50 45	½	Burst out 15° S.W. of γ Arietis, increased in brightness and vanished 10° beneath γ Pegasi.—S. J. J.
Nov. 6 -	10 24 30	½	From 40 Ceti, passed between η and θ Ceti; also 7° E. of β and proceeded 1° further, momentary train.— S. J. J.
„ 13 -	15 26 0	Sirius	From 179° + 22° to 185½° + 21½°. Duration ·7 sec. Bluish, appeared to explode. Leonid.—J. H. B.
Dec. 12 -	12 29 0	0	Magnificent, various colours, for the last 3° or 4° green with red train. Geminid, passed π^4 Orionis and o^2 Eridani, going 2° or 3° further. Course about 20°. Quick. Duration 2·3 secs.—T. W. B.
„ 13 -	14 23 30	½	From 106½° + 16½° to 107½° + 7°. Geminid. Quick, small round head.—W. E. B.

Observers—E. R. BLAKELEY, Dewsbury.
T. W. BACKHOUSE, Sunderland.
W. E. BESLEY, Westminster.
W. F. DENNING, Bristol.
H. CORDER, Bridgwater.
REV. S. J. JOHNSON, Melplash, Bridport.
REV. T. E. R. PHILLIPS, Hendford, Yeovil.
H. J. TOWNSHEND, Leeds.
Place of observation as above, unless otherwise stated.

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Report on the Auroral Displays of 1898.

As it is only recently that the suggestion was made for Members to report auroral observations to the Director of the Meteoric Section, not very much has been done to get together details of last year's displays. The report will be therefore, a short one, and also for the reason that at this time of scarcity of sun-spots, Auroræ are also infrequent. The one fine display of September 9 has already been described at some length in the "Journal," so that a brief record of it here from several observers is all that will be needed.

Many observers, especially those living near towns, where the sky is often more or less illuminated, would doubtless hesitate to record as an aurora a mere faint light in the northern sky, and, of course, towards the summer it becomes increasingly difficult to differentiate them from the zodiacal light, the Milky Way, and twilight.

In the winter it is more easy, and it will be found an interesting plan always to examine such glows with a spectroscope, when the greenish auroral line will very often decide the point, although sometimes it may be too faint for small instruments.

In the future it will be advisable for observers in reporting to the Director, to describe what form the display takes, whether it consists only in a faint glow, whether a distinct arch of light is seen, or streamers appear, or lastly, whether the corona is formed overhead, with the various accompaniments of a really great display. Careful note should be made of the time and position or path of any shifting patches or broken arches of light or specially brilliant streamers.

In the early months of 1898, no auroras seem to have been recorded, but in April some were seen in Scotland, and on April 12, there was a display reported by Mr. Forsyth, at Macduff, N.B., as "fairly extensive, but not bright." At Bridgwater, it was not seen until about 9.10, when a bright glow was noticed along the northern horizon, with sheaves of pale streamers. At 9.20, there was a rather brilliant patch of light in the N.E., which travelled slowly to the N., when it threw up some long streamers, one resembling a curved comet's tail, probably from a secondary streamer forming by the side of the upper part of it. After 9.30, the display waned.

GREAT AURORA OF SEPTEMBER 9.

Several reports of this phenomenon have already been published; to which may be added a note by Mr. J. H. Astbury, of Wallingford, on the Arch of Patches of Light in the S., which he had described in the "Journal" (Vol. IX., p. 25). When first seen, these clouds were just to the S. of θ Aquilæ, and it was curious to note "the manner in which the patches moved across the sky. "They did not simply move as clouds, but the leading (eastern) "end of the patches extended by a very rapid succession of tiny "tongues of light, which appeared to leap over each other from "the end of the patch in a way which I can only compare with "the strong ebullition of molten metal. There was little, if any, "contraction at this end, but at the western end the extension

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" and contraction were both very strongly marked, and were of " the whole width of the patches. The width remained nearly " constant throughout their course, though it varied in the " different patches. I did not see anything of the southern " display after about 8.25, by which time it had descended to the " horizon."

Mr. J. E. Clark, of South Croydon, notes that the display, especially the southern arch, was like a shifting search light. At 9.30, there were streamers W. of magnetic N., with a very distinct spectrum. Earlier in the evening some were tinted with red. At 11 o'clock, the lower edge of the arch was sharply defined. At mag. N., the altitude of the top above the horizon was twice the distance between $\alpha - \beta$ Ursæ Maj., and was distant in azimuth, once the distance between $\alpha - \beta$, W. from N.

Rev. S. J. Johnson reports the display as brilliant: " At 9.20, " as a considerable illumination over a fourth of the horizon from " Arcturus due W., to a point due N., being especially bright " beneath α and β Ursæ Maj. Two streamers, one stretching " beyond β and γ Ursæ Minoris, the other across δ and ϵ. A few " faint streamers after this. At 9.50, the illumination contrasted " strongly with some small black clouds above the W.N.W. " horizon. About 10.5, a deeper yellow colour was noted. At " 10.20, the aurora had faded, but at 11.30, it was again present " with bright low streamer in the N.W."

The Director observed from Clifton Down, and at first, soon after dark a bright display was noticed, somewhat tinged with red, but clouds came over, and hid it for some time. At 10.30, it was brilliantly clear, with a green arch along the N.W. horizon, and occasional streamers through the Great Bear. At 9.50, especially, there were four or five, one being very narrow and sharp. All were to the W. of the Pole Star, and moving slowly from E. to W. Bright light extended some distance E. of N., but the whole display was centred far to the W. of that point.

About midnight, it was still very clear, and the auroral light very beautiful, with brighter streamers, but I do not think I saw any form W. of the Pole Star at any time.

At Bridgwater, no other displays than these were recorded during the whole year.

At the time of the April aurora, sun-spots were very scarce, but as will be remembered there was an extremely fine one at the time of the September display, " the spot having crossed the central " meridian of the sun about 14 hours before the magnetic dis- " turbance set in, which was at its height from 8 to 11 o'clock on " Friday, September 9," as described by Mr. Maunder.

Errata.

In Report for 1897, page 5, in Remarks on April, *for* " Leonids " *read* " Lyrids." Page 10, Meteor of August 4, the time *should read* " 10.33, and the meteor passed $\frac{1}{4}°$ 'left' of κ Cephei," *not* " East."

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SECTION FOR THE OBSERVATION

OF

THE SUN.

DIRECTOR.—REV. A. L. CORTIE, S.J., F.R.A.S.

EIGHTH REPORT OF THE SECTION, 1898.

Introduction.

The present Report is mainly due to the energy and devoted industry of Miss Brown, the late Director of the Section. Almost the whole of the sheets for the Calendar and for the Ledger had been drawn up at the time of her death. The work of the present Director has been chiefly confined to a careful revision of the manuscript. In this work the proof sheets for 1898, of the invaluable series of Greenwich measures of the positions and areas of sun-spots, courteously supplied by Mr. Maunder, and the series of Stonyhurst drawings of the solar surface, have been of very great assistance. By this means the comparatively few gaps in the continuity of the record for the year which existed have been filled up.

The total number of groups recorded in 1898 was only 91, and the days on which no spots were seen amounted to 38. The following table, prepared by aid of the reports so far published, exhibits the rise and fall in the number of groups observed each year, and the corresponding decrease and increase of the days on which no spots were seen on the visible solar disk during the last eight years. It will be noted that the rise to the maximum number of groups in the year 1893, from the year 1891, was somewhat more rapid than the decline from 1893 to 1897. The

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fourth column in the table gives the number of days each year on which no record appear in the reports:—

Year.	Groups.	Number of Days of no Spots.	Days of no Record.
1891 - -	130	16	0
1892 - -	224	0	44
1893 - -	285	0	22
1894 - -	279	0	27
1895 - -	234	0	33
1896 - -	161	3	18
1897 - -	130	21	31
1898 - -	91	38	0

The records for the year 1891 were filled up by the aid of the Greenwich volume, as stated in the Report for that year. During the period from March 28, 1891, to April 14, 1896, or for more than five years, the observations published in these reports show that there was no day on which the sun was free from spots.

Of the 91 groups observed during the year 1898, at least two-thirds were composed of small or insignificant spots. Fifteen of the groups belonged to six separate disturbances, and five more of moderate area (groups 55, 56, 57, 59, 60) crossed the disk in the last days of July and the first half of August. The longest period without any spots was the 13 days, July 2–14. But one group, that which reached its greatest development in the month of September, was not only remarkable in itself for its great size, but still more, in that it appeared at a period in the cycle of solar activity, when the minimum was fast approaching. In area, when at its greatest phase (2235 millionths of the visible hemisphere), it did not fall far behind any of the largest spots of the last two maxima. It is noteworthy, too, that the previous year 1897, at least three years after the maximum, was marked by the enormous group of the month of January, probably the greatest recorded during the last two cycles. It is a well-established fact that the descending arms of the curves of solar activity are much less steep than the ascending arms. Is it also true that the years of decline are marked by these occasional great outbursts of the seemingly pent-up solar energies before their final subsidence? The point is worth inquiring into.

The particular group under discussion crossed the visible disk four times, being first seen on August 11, and last seen on November 7. Its history is given in the "Ledger", under the numbers 61, 66, 73, and 79. It is illustrated by a beautiful drawing by Mons. Antoniadi, published in the "Journal," Vol. IX., No. 12, page 70, and it has been considered sufficiently important and interesting to receive further illustrations of its appearance, during its second and third passage across the disk, from sketches by Mr. Corder, Mr. Astbury, and Prof. Pereira. During its first appearance (group 61) it consisted of a few insignificant dots, and

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its last appearance (group 79) was of a precisely similar character. Magnificent faculæ of great extent clustered thickly round it when it reached the W. limit of the sun on October 12, at the end of its second transit of the visible disk. Prof. Pereira's drawing of October 6 shows the "black holes" in the umbra, as also a bright bridge very conspicuously. We cannot, however, subscribe to his opinion, expressed in his note, that these conjoined phenomena are conclusive against a possible elevation of the spot on the solar surface.

Great industry has been displayed by the observers of the Section in noting the first beginnings of an outburst of spots, especially by Mr. Bartlett, and by Mr. Hadden, who has supplied a very complete catalogue and description of nearly all the groups recorded. From these observations about six cases were found which could be utilised in studying the connection between the faculæ and the first beginnings of a spot disturbance, a subject to which the present Director called particular attention in a paper printed in the "Journal," Vol. IX., No. 3, and which can be more easily studied at the minimum than at the maximum period of solar activity. Up to the present time Father Sidgreaves, from a careful study of a selection of the Stonyhurst series of drawings, has found six cases in which faculæ certainly preceded the first beginnings of the spot group and three other probable cases. From the materials I have been able to discuss, I have found one more certain case. It occurred in the group which crossed the disk in the first days of November, and which died on the visible hemisphere during its second passage on December 2. The following table in which a summary of its life history is given will enable observers to study the matter for themselves from the Greenwich publication, and from our Report.

Group B.A.A.	Number Greenwich.	Max. Area.	Mean Heliographic, Long.	Mean Heliographic, Lat.	Central.	First seen.	Last seen.
80	4807	680	200	+6	Nov. 5	Oct. 31	Dec. 2
85	4816	30	211	+5	Dec. 1		

The observations are as follows:—On October 30 two small compact bright patches of faculæ were drawn at Stonyhurst at the E. limb of the sun at 11.50 a.m., in the position longitude 199° and latitude from +5° to +8°. They had all the characteristic appearance of new faculæ; and, moreover, no disturbance of the solar surface by either spot or faculæ had been recorded in this region (as a study of the positions in the Greenwich volume shows) since August 11, when a group of faculæ was measured at longitude 200·7° and latitude +12·5°; that is, during a period of about three solar rotations. The Greenwich photograph, one of the Indian series, taken at $7^h\ 38^m$ a.m., does not record the faculæ. No drawing was made at Stonyhurst on

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October 31; at $8^h\ 10^m$ a.m., Miss Brown observed and saw no spots, but at $9^h\ 15^m$ Mr. Bartlett saw a few hardly perceptible spots near the E. limb. They were probably too faint to be shown on the photograph taken at Greenwich at $12^h\ 40^m$, for they are not recorded, but the position of the faculæ is given at longitude 203·3° and latitude +8·1°. The next day, November 1, the spot group was photographed at Greenwich, at mean position longitude 202·1° and latitude +8·3°. This evidence of the connection of spot-group and faculæ is corroborated by the Stonyhurst drawing of the same date. During the second rotation the group consisted of a few small spots.

NAMES of MEMBERS of the Section.

Name.	Address.	Instrument.	——
ASTBURY, J. H.	Wallingford	3½-in. O.G.	Drawings (projection).
BARTLETT, J.	Bramley	4-in. O.G.	„ „
BELL, J. E.	Sydney, N.S.W.	„	„ „
CORDER, H.	Bridgwater	6½-in. Spec.	„ „
CORTIE, Rev. A. L.	Stonyhurst	15-in. O.G.	Drawings, measurements of position.
ELD, The Rev. F. J.	Polstead Rectory.	8½-in. Spec.	Measurements of position. Tracings.
HADDEN, DAVID E.	Alta, Iowa, U.S.A.	4-in. O.G.	Daily record.
PEREIRA, J. DE MORAES.	Azores	4½-in. O.G.	Drawings and measurements of position.
SIMPSON, DAVID G.	Denmark Hill, London.	„	Drawings (projection).
SMART, Dr. D.	London	10-in. Spec.	Photographs and measurements of position.
SOLÁ, JOSÉ COMAS	Gerona, Spain	—	——
TOWNSEND, J. S.	Sevenoaks	4½-in. O.G.	Photographs, diagrams, and measurements of position.
WADMORE, J. M.	Exmouth	3-in. O.G.	Direct vision.
WAUGH, The Rev. W. R.	Portland	4½-in. O.G.	Drawings (direct vision).
WHICHELLO, Dr. H.	Chester	„	Drawings (projection).

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Calendar of Sun-spots and Faculæ.

JANUARY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	1, 2	(A few small spots near W. limb at 8.30 p.m seen by Mr. Hadden. No. 129 of December 1897.)
2	1, 2, 3, 4	W. 5° to 15° N. One patch to the S. f. group 129 of December 1897?
3	1, 2, 3, 4	E. numerous, region of 4. Not observed on the 2nd.
4	1, 2, 4	E. region of 4.
5	1, 2, 4	E. region of 4. W. position of 1.
6	1, 2, 4	E. still visible round 4. W. position of 1.
7	1, 2, 4	E. a little S. of equator, faint but numerous. W. chiefly to the N. of 1.
8	2, 4	W. 14° to 17° S.
9	2, 4	W. region of 2.
10	2, 4	W. same latitude.
11	4	W., S. of equator, some distance from limb.
12	4	W.
13	4, 5	(Two dots near E. limb, possibly belonging to group 6.)
14	4, 5	E. conspicuous, S. f. 5.
15	5, 6	E. round group 5, especially the f. spot.
16	5, 6, 8	E. region of group 8.
17	5, 6, 8	Central 5, following 8.
18	5, 6, 7, 8	E. central 8.
19	5, 6, 7, 8, 9.	
20	5, 6, 7, 8, 9.	
21	5, 6, 7, 8, 9.	
22	5, 6, 7, 8, 9	E. numerous, half-way between 9 and limb. W. round 6 and 7.
23	5, 6, 7, 8, 9	E. 3° to 15° S.
24	5, 7, 8, 9	E., W. central 7, following 5.
25	5, 8, 9	E. following 5.
26	8, 9.	
27	9.	
28	9.	
29	9.	
30	9	W. (a bright ridge extending along 9 on the W. side).
31	9	W. extensive 5° N. (position of 9). Slight on E.

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FEBRUARY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	No spots.	
2	No spots.	
3	No spots.	
4	10, 11.	
5	10, 11	E. numerous, region of 11, one patch far from limb. Central 10.
6	10, 11	E. numerous, about 11 and following.
7	10, 11, 12 13	E. 2° to 9° S. Position of 13 and a patch to the N.
8	10, 11, 12, 13	E. region of 13. W. region of 12.
9	10, 11, 12, 13, 14	(A small spot S. f. 10, about 20°, not numbered.) E., especially N. of 13 and 14. W., S. p. 12.
10	10, 11, 13, 14	E. 5° to 16° S. W. 17° to 39° N.
11	10, 13, 14	E. f. 14 W. Same position as on the 10th.
12	10, 13, 14, 14A	E. Two dots in faculæ. W. 0° to 16° S.
13	13, 14	E. on a line with group 14, but far behind. W. bright, same position as 12th.
14	13, 14	E., same as on the 13th. W., a patch to the S. far from limb.
15	13, 14, 15, 16, 17	E. 0° to 15° N. 0° to 5° S.
16	13, 14, 15, 16, 17	E. 0° to 10° N. around 16 S.
17	13, 14, 14B, 15, 16, 17, 18, 19.	
18	13, 14, 14B, 16, 17, 18, 19.	
19	13, 14, 16, 17, 18, 19.	
20	14, 17, 18, 19	W. region of 14. Numerous.
21	17, 18, 19	Bright patch W. N. of place of 14.
22	17, 19, 20	E. round 20.
23	17, 19, 20	E. region of 20, and some distance to the N. Round 17 and 19. Compact.
24	17, 19, 20	E. region of 8 to N. of 20. Branching round 17 and 19.
25	17, 19, 20	W. 0° to 15° N. 0° to 7° S.
26	17, 19, 20	W. 0° to 12° N. 0° to 5° S.
27	20, 21.	
28	20, 21	E. 0° to 15° S. Also two separate patches more N.

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MARCH 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	20, 21	E. 8° to 14° S. Compact about the spot 20.
2	20, 21	E. f. group 21, numerous. Compact about 20.
3	20, 21, 22, 23	E. 8° to 15° S.
4	20, 21, 24	E. region of 24. W. one patch, lat. of 22.
5	20, 21, 24, 25, 26	W. round and S. of 20.
6	21, 24, 25, 26, 27.	
7	21, 24, 25, 26, 27	E. region of 25, 26, 27. Especially bright N. of 27. Position of February train.
8	21, 24, 24A, 25, 26, 27	E. f. 27. Two or three small spots near W. limb in S. lat.; also on the 9th.
9	21, 24, 24A, 25, 26, 27.	
10	21, 24, 24A, 25, 26, 27	E. faint, f. 26 and 27. W., S. f. 21.
11	21, 25, 26, 27	W. region of 21.
12	25, 26, 27	W. on a line with 25.
13	25, 26, 27	E. extensive (a dot in N. lat.). Faint spots near centre of disk observed only by Mr. Hadden, also 14th and 15th.
14	25, 26, 27.	
15	25, 26, 27	W. round 25, 26, 27.
16	25, 26, 27, 27A	E. conspicuous round 27A.
17	25, 27, 27A, 27B	W. region of 25. A few in N. lat. region of 23.
18	27.	
19	No spots	(Two dots near centre of disk, seen only by Mr. Hadden.)
20	No spots	W. small patch near limb.
21	28. 29?	Groups 28 and 29. Probably those seen by Mr. Hadden. Greenwich and Stonyhurst no spots.
22	28, 29	(One small spot W. about 17° S. lat.) Not in Greenwich series.
23	No spots.	
24	No spots	E. far from limb. W. one patch far from limb.
25	30	E. round 30. W. slight faint patch.
26	30.	
27	30.	
28	30	E. limb extensive.
29	30	E. 7° to 20° S. Some far from limb.
30	No spots.	
31	31, 32	E. p. 32.

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APRIL 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	31, 32	E. 3° to 20° S. extensive.
2	32	E. 0° to 23° S.
3	32	E. 0° to 26° S.
4	32	E. 0° to 4° N. 0° to 25° S. Very extensive from 32 to E. limb.
5	32	E. 12° S., W. 5° to 10° S., and 15° S. Conspicuous far from limb.
6	32.	
7	32	Small patch E. limb.
8	32, 33	W. 10° to 12° S.
9	32, 33.	
10	32, 33	W. p. and surrounding group 32.
11	32, 33	W. round 32 extensive.
12	32, 33	W. region of 32. Beautiful branches.
13	32, 33	W. round 32, and far to the S. Also around 33.
14	No spots.	
15	No spots	W. position of 32.
16	No spots.	
17	No. spots,	
18	No spots.	
19	No spots	E. two patches. W. one patch
20	No spots.	
21	No spots	E., a small patch to the N. W. further from limb.
22	34	E. 20° or more S. W. 10° S
23	34	E. region of 34.
24	34	E. round and f. 34.
25	34, 34A.	
26	34A, 34B	E. region of 34B.
27	34A, 34B	E. extensive near limb.
28	34A, 34B	E. with a small spot f. 34B.
29	34A, 34B	Region of 34A.
30		A few small spots.

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MAY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1		Three spots, Stonyhurst, near W. limb. Greenwich group 4732.
2	34, 34A, 35.	
3	35	E. near limb. W. near limb.
4	35.	
5	35, 37	E. conspicuous around 37. W. far from limb to the S.
6	35, 35A, 36, 36A, 37, 38	E. a ring over penumbra f. 38 W. far from limb S.?
	35, 35A, 36, 36A, 37, 38	E. f. 38. W. near limb. S.?
8	36, 36A, 37, 38	Only observed by J. Comas Solá.
9	36, 36A, 37, 38.	
10	36, 36A, 38.	
11	36, 38.	
12	36, 38	Bright dot E. Stonyhurst, W. Greenwich and Stonyhurst.
13	38, 39	E. around 39.
14	38, 39.	
15	38, 39	W. numerous f. 38.
16	38, 39, 40.	
17	38, 40.	
18	38, 40, 41	E. 9° to 20° S.; f. 40, and in a ring to the N. of it. W. 3° to 13° S., region of 38.
19	40.	
20	40	E. numerous, with a dot a little N.
21	40	Many scattered near W. limb.
22	40, 40A	W. far from limb to the S.
23	40, 40A	W. far from limb, N.? Large atch near E. limb.
24	40, 40A	E. and W.
25	40, 40A	A small spot near E. limb in N. lat.; seen also on the 26th by Mr. Hadden.
26	40, 40A	Very bright compact masses about 40. E.
27	40A	W. region of 40 inconspicuous. E many faint patches.
28	40A, 42	Faint patches E. and W
29	40A.	
30	43, 44.	
31	43, 44.	

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JUNE 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	43, 43A, 44	
2	43, 43A	A few dots not numbered in long. 101° lat. 6° N. Seen also on the 3rd.
3	43, 43A	W. region of group 43.
4	43A.	
5	43A, 45	E. with a dot near limb; also seen on the 6th.
6	43A, 45.	
7	43A, 46	W. bright round 43A, and a patch f. 46 E.
8	No spots	W. bright patch. Penumbral patch.
9	No spots	Magnificent faculæ W. Fainter patches E.
10	No spots.	W. Three minute spots near central meridian.
11	No spots	W. A pair of very small spots.
12	No spots	(A tiny pair not numbered near central meridian.)
13	47.	
14	47.	
15	47	E. near limb at 5.30 p.m. S.?
16	47, 48.	
17	47, 48	W. region of 47, bright and numerous.
18	47, 48	W. same lat. 10° to 20° N. Central to 48.
19	48	E. very extensive, lat. of 49. Bright patch W.
20	48, 49	E. region of 49, especially S. of it.
21	49.	
22	49	E., a patch at some distance from limb. Several scattered faint patches.
23	49	E., a few near equator. W. with a small spot not numbered.
24	49.	
25	49, 50, 51	W. bright to the N. and a narrow stream to the S. A small spot near central meridian at 6.15 p.m.
26	49, 50, 51	E. round 51.
27	49, 50, 51, 52.	
28	49, 51, 52	Surrounding the groups.
29	49, 51, 52	W., S. f. 49 extensive.
30	51.	

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JULY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	51	W. latitude of 49°.
2	No spots	W.
3	No spots.	
4	No spots	E. extensive. N. Faint W.
5	No spots	E. 10° to 15° N. Long. about 269° to 257°. W. 4° to 14° S.
6	No spots	W. same lat., but nearer limb.
7	No spots	E. about 17° S. W. 0° to 14° S.
8	No spots	E. same lat. as on the 7th, further from limb.
9	No spots	Faint patches E. and W.
10	No spots	Faint patch W.
11	No spots	E., a few near limb.
12	No spots	E., very few.
13	No spots	A bright isolated patch 20° from W. limb.
14	No spots	W. faint.
15	53	W. same latitude.
16	53.	
17	53	E. to the S. Some far from limb. W. one bright patch N.
18	No spots	E. few, one patch bright. W. same lat. as on the 17th.
19	54.	
20	54	W. faint. Bright, compact about spot group.
21	54.	
22	54.	
23	54	E. to the S. Some far from limb.
24	54	E. 20° to 24° S.
25	56	E. with three very small spots. Position of faculæ on the 24th.
26	No spots	Few unstable evanescent spots.
27	No spots	W. about 3° N.
28	No spots	Few very small unstable spots.
29	55, 56.	
30	55, 56	E. region of 57 and p. W. about 10° S.
31	55, 56, 57	E. round 57 and to the S.

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AUGUST 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	55, 56, 57, 58.	
2	55, 56, 57, 58, 59	E. region of 59. W. probably latitude of 55.
3	56, 57, 59.	
4	56, 57, 59	W. 5° to 10° S., far from limb. Surrounding 59.
5	56, 57, 59	W. region of 56.
6	57, 59.	
7	57, 59	W. extensive. Position of 56.
8	57, 59	W. same locality, nearer limb.
9	57, 59	Central to 57. Few faint patches W.
10	57, 59.	
11	57, 59, 60, 61	W. around and f. 57.
12	59, 60, 61	W. f. 59. S.W. region of 59.
13	59, 60, 61.	
14	60, 61	W. one patch near limb f. 59. E. limb to the S., with a small spot at 8.30 p.m. (Iowa) in N. lat.
15	60, 61	E. with two very small spots where faculæ appeared on the 14th.
16	60, 61	E. far from limb; seen also on the 16th and 17th.
17	60, 61	W. p. 61, and around 60
18	60, 61	W. bright, position of 61. Mr. Bartlett reports a dense mass to the N. of 60.
19	60	W. region of and S. of 60.
20	No spots	E. small, near limb.
21	62.	
22	62, 63	W. 13°. S.
23	62, 63	Central.
24	63	W. round and far S. of 63.
25	No spots	W. bright, position of 63 and a patch to the S. further from limb.
26	64, 65.	
27	64, 65	E. round and f. 65.
28	64, 65	E. circular patches f. 65.
29	65	E. extensive to the S. Two small spots a little E. of meridian in S. lat.
30	65	E. 10° to 22° S.; far from limb.
31	65	E. 10° to 30° S; extensive, far from limb. W. bright patch to the N., and one about 7° S.

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SEPTEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	65	E. rather faint, position of 66? W. a few round small spots near limb.
2	65, 66.	
3	65, 66	E. 10° to 20° S.
4	65, 66	E. 7° to 24° S. A large mass between large spot and limb. Mr. Wadmore reports them as being very complicated.
5	65, 66	E. 6° to 20° S. W. preceding 65 for most part.
6	65, 66	E. f. group 66.
7	65, 66	W. f. 65.
8	66	Near W. limb, faint.
9	66	W. limb. N.?
10	66	E. 8° S.
11	66, 67.	
12	66, 67.	
13	66, 67	W. 10° to 31° S.
14	66, 67, 68	W. 10° to 25° S.
15	66, 67, 68, 69	W. 8° to 22° S. Conspicuous.
16	67, 68, 69	E. and bright patch round spot.
17	67, 68, 69.	
18	67, 69.	
19	67, 69	W. bright, f. 68. Round 67.
20	69	W. 4° to 18° N.
21	69	E. close to limb. Small but bright.
22	69	E. very bright, 0° to 6° N. Nearly position of 65.
23	69, 70	E. 14° N. and 0° to 10° N.
24	69, 70	W. region of 69.
25	70?	W. f. 69.
26	70?, 71	E. 10° to 20° S. (small flaky). N. region of 71.
27	70?, 71	E. two very bright patches to the S.
28	70?, 71, 72	E. round and N. of 72.
29	71, 72	E. 6° to 13° S. bright, p. 73.
30	71, 72, 73	E. f. 72 and region of 73. (Large group returned.)

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OCTOBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	71, 72, 73	E. 0° to 20° S. (Return of large spot.)
2	71, 72, 73	E. 0° to 25° S. W. 0° to 10° N.; 0° to 9° S.
3	71, 72, 73	E. scattered patches, f. 73.
4	71, 72, 73, 74	Surrounding 71, f. 73.
5	72, 73, 74.	
6	72, 73, 74	E. 5° to 7° N. W. 10° to 14° N.
7	72, 73, 75.	
8	72, 73, 75	W. 20° N. Central 73.
9	72, 73, 75	E. 15° to 20° S. Central compact, 73; f. 75. W.
10	73, 75	E. Central, compact 73. Extensive W.
11	73, 75	W. limb large masses c. and f. 73, Central 75. E. detached patches.
12	75	W. 0° to 14° S. Fine mass of spreading faculæ.
13	75.	
14	75.	
15		A very small spot.
16	75.	
17	76.	
18	76A.	
19		A small spot.
20		A very small spot.
21		A very small spot. Patch of faculæ E.
22	77.	
23	77	E. Region of 77. W. 8° to 18° N.
24	77.	
25	77.	
26	77, 78.	
27	77, 78	Fine patches E. limb.
28	77, 78	E. 5° to 20° S.
29	77, 78, 79	Region of 79. Bright patch E.
30	77, 78, 79	E. Region of 79 extensive.
31	77, 78, 79, 80.	

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NOVEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	77, 78, 79, 80, 81	Bright, 7° N. About 180° long. E. 0° to 10° S. Region of 81.
2	77, 78, 79, 80, 81	E. Round 81. W. conspicuous region of 77.
3	77, 78, 79, 80, 81	E. region of 81 and W. region of 77.
4	78, 79, 80, 81	E. around and f. 81.
5	79, 80, 81, 82	W. position of 78.
6	79, 80, 81, 82	W, 10° to 23° S., p. 79. (Last return of big spot.)
7	79, 80, 81, 82	P. and f. 79, very extensive W.
8	80, 81, 82	W. 10° to 30° S. (same).
9	80, 81, 82	Central 80.
10	80, 81A, 82	W. 3° to 16° N.
11	80, 81A, 83	W. scattered and faint patches.
12	81A, 83.	
13	82, 83	W. about 0° to 10° N.
14	83.	
15	83.	
16	83	E. to the N.
17		Two very small spots.
18	84.	W. Extensive far from limb. About 3° to 10° S. Position of 86?
19	84	E. and W. bright.
20	84	W. 7° to 17° S.
21	84.	
22	84.	
23	84.	
24	84.	
25	84.	
26	84, 86	W. region of 83.
27	86	Numerous around 86.
28	85, 86.	
29	85, 86	Patches E limb.
30	86	E. 5° to 17° S.

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DECEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	86.	
2	86, 87.	
3	86, 87.	
4	86, 87	W. 15° to 25° S.
5	86, 87.	
6	86, 87.	
7	86, 87	W. 5° to 10° N. Long. about 211° to 206°, nearly position of 80. (85 a return of it.)
8	86, 87	W. S. of 86. A small patch far from limb.
9	87	W. 7° to 14° S. Long. 182° to 174°. The f. nearly position of 81, ? and 14° to 16° S. Long. 172°.
10	87	Patches E. and W. small.
11	87.	
12	87.	
13	87	E. bright. 8° to 13° S. W. region of 87.
14	No spots.	
15	No spots	E. faint, far from limb. Penumbral patch.
16		Small spot.
17		Small spot.
18	88	E. round 88.
19	88	E. region of 88.
20	88	E. A very few to the S.
21	88.	
22	88 ?	E. few and faint, 14° to 23° S.
23	No spots	E. About 7° to 13° N. Long. 220° to 210°, nearly position of 80, and 23° S. Long. 220°.
24	No spots.	
25	No spots.	
26	No spots.	
27	No spots.	
28	89	E. S. f. group 89, some far from limb. Position of 90 ?
29	89, 90.	
30	89, 90	E. 16°/17°. Long. 133° to 128° nearly position of 87.
	89, 91	E. around 91.

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Sun-spot Report, 1898.

LEDGER.

Jan. GROUP 1. *Long.* 311°. *Lat.* 15° N.

1–7. A normal spot, near the central meridian on the 1st, major axis about 30″. Little change took place before reaching the limb. 128 of December 1897.

Jan. GROUP 2. *Long.* 270°. *Lat.* 8° N.

1–10. A normal spot. Nucleus partly bridged on the 3rd and 4th. Major axis 25″ on the 7th. It decreased rapidly before disappearance by rotation. (Group 130 of December 1897.)

Jan. GROUP 3. *Long.* 253°. *Lat.* 12° N.?

2–3. Two faint little spots; on the 3rd only one.

Jan. GROUP 4. *Long.* 210°. *Lat.* 11° N.

2–14. A normal spot seen by Mr. Hadden (in Iowa) at 5 p.m. on the 2nd. It showed little change before reaching W. limb (at 4.18 p.m. on the 14th) except some signs of disruption on the 8th and 9th. In major axis it hardly exceeded 35″. Penumbra when near W. limb on the p. side. (A return of the leading spots of Group 124 of December 1897.)

Jan. GROUP 5. *Long.* 64°. *Lat.* 10° S.

13. A normal spot observed by Mr. Hadden in Iowa, close to E. limb at 5 p.m.
14. Penumbra wider on the f. side, nucleus bulging to the S. A misty trail s. f.
15. Two medium sized spots, the f. probably developed from the trail above mentioned.
16. The p. with large nucleus, the f. more dispersed.
19. One spot; major axis 35″.
20. Little change.
21. Decreasing; two small spots f.
22. Broken up at the rear.
23. Near limb.

Jan. GROUP 6. *Long.* 99°. *Lat.* 15° S.

15. A few dots.
16. Nine small spots.
19. A medium sized spot with divided nucleus, several small ones p. some distance apart.
20. Very much reduced; penumbra on the p. side only.
21. Nebulous; no distinct penumbra, one spot p.
22. Solitary and still more reduced.

Jan. GROUP 7. *Long.* 89° to 85°. *Lat.* 6° S.

19–23. A spot about 25″ in major axis, vertically inclined, with a little stream following, which soon decreased, the leader also dwindling.

Jan. GROUP 8. *Long.* 35°. *Lat.* 9° N.

16–23. A normal spot; major axis 30″, nucleus bridged on the 22nd and and 23rd. It showed little change, and must have decreased rapidly, not being visible on the 26th. (Four nearly normal spots were visible on the 19th.)

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Jan. GROUP 9. *Long.* 358°. *Lat.* 5° N.

19. A considerable spot near E. limb.
20. Nucleus curving westward.
21. Normal, fimbriated.
22. Larger, 1′ of arc in diameter, a portion to the W. almost severed.
23. Small spots f. (not observed by members in England after this date).
26. More outliers.
27. Several portions dividing and embracing more than half of the circumference.
28. Still more broken up.
29. Only two of the smaller fragments with nuclei.
30. Nucleus single, penumbra long, oval. A bright ridge of faculæ extending along the edge nearest the limb. Whole appearance strongly suggestive of the depression theory.
31. Close to limb at 12, appearing as a long dark line, without penumbra.

Feb. GROUP 10. *Long.* 176° to 171°. *Lat.* 6° to 8° S.

4–12. Three small spots. A new outburst, with slight penumbra on the 5th. More in number, but smaller on the 7th. Not seen at 9.45 a.m. on the 8th, but observed by Prof. Pereira at 0.18. One increased a little in area, the rest gradually dying out.

Feb. GROUP 11. *Long.* 145°. *Lat.* 11° S.

4–10. A small nebulous spot which did not increase, and vanished before reaching W. limb.

Feb. GROUP 12. *Long.* 229° to 224°. *Lat.* 10° N.

7–9. Two spots with slight penumbra in the western hemisphere. The f. increased a little, penumbra wider on the p. side; on the 8th the p. soon disappeared.

Feb. GROUP 13. *Long.* 102°. *Lat.* 8° S.

7–19. A small normal spot near E. limb on the 7th. Nucleus double on the 9th; cloven on the 12th and 13th; elongated and entire when near the central meridian, with major axis 35″. It decreased before reaching the limb.

Feb. GROUP 14. *Long.* 97° to 83°. *Lat.* 5° to 8° S.

9. A few insignificant spots near E. limb. (Positions of Group 7.)
10. Rather more in number.
11. A wide stream, three spots with slight penumbra.
12. Great increase, the leader and the last spot much larger, both bridged, many smaller ones between in curves.
13. The p. quadrangular, the f. with both nucleus and penumbra curving westward, intermediates more in a line.
14. The f. nearly vertical, bridged to the S. but less curved, intermediates larger. Length of train, including Group 13, 129,960 miles. The f. spot 66″ in major axis.
15. The p. bridged, the f. broken up to the S. and merging into the intermediates, which are again altered in form and position.
16. The p. again curved, the f. with three nuclei, all of them bridged, the rest also more separated and smaller.
17. The p. two-lobed, the f. very disjointed and curving to the S.
18. The p. bridged, lesser spots fast disappearing, leaving a larger but still fragmentary one at the rear.
19. Much foreshortened, the p. normal; the rest much reduced.
20. Only the f. visible at noon.

Feb. GROUP 14A. *Long.* 87°. *Lat.* 3° N.

12. A very small pair N. f., Group 14. On the 13th and 14th several single spots widely separated appeared in advance.

Feb. GROUP 14B. *Long.* 72°. *Lat.* 9° S.

17–18. Two small spots f. Group 14.

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Feb. GROUP 15. *Long.* 121°. *Lat.* 10° S.
15–17. A little cluster. On the 17th in two sets near W. limb.

Feb. GROUP 16. *Long* 16°. *Lat.* 14° S.
15–19. A small double spot, with a few outliers at some distance from E. limb on the 15th, single on the 16th and 17th; afterwards a few very small spots in a line.

Feb. GROUP 17. *Long.* 2°. *Lat.* 6° N.
15–26. A normal spot, major axis about 40″, bridged in two places on the 18th and 19th, in form like the figure 8 on the 20th; afterwards with two nuclei. (Forming a triangle with Groups 18 and 19.)

Feb. GROUP 18. *Long.* 9°. *Lat.* 1° S,
17–21. A few small spots, with slight penumbra on the 18th, varying a little in position.

Feb. GROUP 19. *Long.* 2°. *Lat.* 1° S.
17–26. A normal spot, resembling 17, bridged on the 18th, curving westward on the 19th and 20th, with three nuclei on the 22nd, dots p. on the 23rd, nucleus single on the 25th. When near limb slight penumbra on the f. side and bright faculæ on the p. (In nearly the same position as Group 9.)

Feb. GROUP 20. *Long.* 267° to 259°. *Lat.* 8° to 11° S.
22. Two very small spots near E. limb.
23. One spot.
25. With two nuclei and a little penumbra.
26. More activity. Small spots and dots p.
27. Two considerable spots.
28. Two normal spots nearly equal in area, the f. about 40″ in major axis, with a few outliers.
Mar.
1. Both with divided nuclei.
2. The f. broken up to the N.
3. The p. broken up to the S. The f. fast decreasing.
4. Both very small.
5. One spot, still more reduced.

GROUP 21. *Long.* 189°. *Lat.* 7° S.
Feb. 28–Mar. 11. Two little spots, with a few outliers on March 5. The p. increased a little in area, attaining 25″ in major axis on the 4th and 5th. The f. about half as much. On and after the 10th the p., somewhat reduced, only remained.

Mar. GROUP 22. *Long.* 279° to 276°. *Lat.* 7° to 9° N.
3. A wide pair of faint spots in the western hemisphere.

Mar. GROUP 23. *Long.* 178°. *Lat.* 14° S.
3. A small faint spot S. f. Group 21.

Mar. GROUP 24. *Long.* 150°. *Lat.* 8° S.
4–10. A spot with slight penumbra showing but little increase; small spots and dots f. One only observed on the 10th.

Mar. GROUP 24A. *Long.* 159°. *Lat.* 10° S.
8–10. A few very small spots and dots, which varied in number, preceding Group 24.

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Mar. GROUP 25. *Long.* 128° to 110°. *Lat.* 10° to 13° S.

5. A small penumbral spot near E. limb.
6. Two spots nearly equal in area.
7. Both increased, many small nuclei and a few outliers.
8. A broad stream, much subdivision.
9. Components still more numerous.
10. Changing rapidly, some of the spots amalgamating. Mr. Townsend observed reversals of the C. line over one or two of the p. spots and faculæ.
11. On the central meridian, nuclei larger, the final spot now quite distinct from the rest.
12. About five considerable spots p. One exceeding the rest in area and very compound, nucleus shaded off.
13. Still changing. Nucleus of chief spot 1′ of arc in length.
14. Nucleus less elongated but more complex. Final spot more broken up and spiral in form.
15. Train more simplified and in three sections, leading spot with a portion detached on the f. side. Chief spot a mass of nuclei, but evidently disintegrated, the interior lighter in tint than the rest.
16. Chief spot splitting up, the final fast disappearing.
17. Largest spot near limb.

Mar. GROUP 26. *Long.* 116°. *Lat.* 12° N.

5. A penumbral spot near E. limb.
6. Penumbra nearly equal E. and W. A smaller spot f.
7. The f. with two nuclei.
8. Bridged, the f. broken up.
9. Nucleus tripartite.
10. More abnormal.
11. A portion to the S. severed.
12. Reuniting.
13. Gaping to the N. Nuclei in a semi-circle, none f.
14. Four nuclei.
15. Penumbra disappearing.
16. Only two small spots, without penumbra.

Mar. GROUP 27. *Long.* 104°. *Lat.* 7° S.

6–18. A normal spot which showed but little variation except in the form of the nucleus, which was double on the 7th, had a small portion severed to the S. on the 13th, and to the N. on the 14th. Major axis 45″. A few small outliers preceded from the 12th to the 16th.

Mar. GROUP 27A. *Long.* 300°. *Lat.* 10° N.

16–17. A single small spot at some distance from E. limb observed only by Prof. Pereira and Mr. Hadden. Not recorded Greenwich or Stonyhurst. But fine faculæ about position seen at Stonyhurst, March 16.

Mar. GROUP 27B. *Long.* 1°. *Lat.* 6° S.

17. One or two very small spots seen by Prof. Pereira.

Mar GROUP 28. *Long.* 8°. *Lat.* 2° S.

21–22. A pair of very small spots in the western hemisphere.

Mar. GROUP 29. *Long.* 359°. *Lat.* 2° N.

21–22. Another little pair, probably observed by Mr. Hadden on the 21st.

Mar. GROUP 30. *Long.* 217°. *Lat.* 13° S.

25–29. One or two very small spots.

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Mar. 31. April 1. } GROUP 31. *Long.* 173°. *Lat.* 15° S.
A little spot in the Eastern hemisphere, almost invisible. April 1.

Mar. GROUP 32. *Long.* 134° to 126°. *Lat.* 12° S.
31. A penumbral spot very near E. limb at 11 a.m. (A return of Group 25.)
April.
1. Nucleus double, a smaller spot f.
2. Nucleus very irregular, penumbra nearly equal but fainter on the f. side.
3. Nucleus singularly split up lengthwise.
4. A portion severed both to the N. and S. Major axis 55″, f. spot 30″.
5. Very complex, pointed to the N., f. spot circular.
6. Further change, many small nuclei; dots f. at some distance.
7. Elongated but decreasing, little penumbra, nuclei beaded, f. spot with more outliers.
8. Scattered fragments only, p. two veiled spots.
9. One small spot only p., the f. normal.
10. Little change, the veiled spots almost gone.
11. The f. only left; faculæ extensive.
12. Little change.
13. Very near limb, faculæ streaming to the S.

April GROUP 33. *Long.* 94° to 90°. *Lat.* 17° S.
8–13. A few dots on the 8th, E. of central meridian, increasing a little in number and area until after the 10th, when two, widely separated, only remained.

April. GROUP 34. *Long.* 202°. *Lat.* 10° N.
22–25. One or two very small spots.

April GROUP 34A. *Long.* 225°. *Lat.* 11° S. ?
25–29. A few very faint spots, observed only by Prof. Pereira and Mr. Hadden. Two of them increased a little in area on the 29th.

April GROUP 34B. *Long.* 159°. *Lat.* 16° S.
26–29. At first two small spots near E. limb, as many as eight on the 28th and fifteen on the 29th.

May GROUP 35. *Long.* 84°. *Lat.* 14° N.
2–7. A few very small spots, seen only as dots by Mr. Hadden on the 7th at 1.15 p.m.

May GROUP 35A. *Long.* 53°. *Lat.* 8° N.
6–7. Six small spots between E. limb and Group 35, only observed by Mr. Hadden and Mr. Astbury.

May GROUP 36. *Long.* 60°. *Lat.* 11° S.
6–10. Three little spots, increasing in number, but after the 10th one only.

May GROUP 36A. *Long.* 34°. *Lat.* 13° S.
6–10. Two little pairs with slight penumbra, s.p. 38.

May GROUP 37. *Long.* 46°. *Lat.* 10° N.
5–9. A few very small spots reduced to one or two dots on the 9th.

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May — GROUP 38. *Long.* 28° to 13°. *Lat.* 7° S.

6. Two medium sized spots following each other.
7. Penumbra chiefly confined to the N. and S., many outliers.
8. No details.
9. The p. with oval nucleus, the f. with a bright bridge extending partly through the p. portion of the penumbra, but not across the nucleus.
10. Both more normal. A drawing by Prof. Pereira shows the umbra of the f. bridged laterally.
11. Both nearly equal in area.
12. The f. with several small nuclei.
13. The p. carrot-shaped, elongating and breaking up at the extremity into a train of small spots. The f. with penumbra on the S. side only. Many outliers eastward.
14. The p. more parallel to the equator. The f. more vertical, whole group kite-shaped.
15. Decreasing. The p. with two nuclei, the f. breaking up and with only a little penumbra.
16. Leader much reduced.
17. Nearing limb.
18. A small single spot only visible.

May — GROUP 39. *Long.* 295° to 286°. *Lat.* 8° to 11° S.

13–16. Two or three small spots near E. limb. On the 16th reduced to one.

May — GROUP 40. *Long.* 244°. *Lat.* 16° S.

16–26. A small penumbral spot near E. limb at 6 p m. on the 16th. Stonyhurst seen 4.20 p.m. A smaller one f. in close proximity, which soon disappeared. Nucleus bridged on the 22nd. Major axis 20″, a few outliers to the S. After the 23rd smaller and more irregular.

May — GROUP 40A. *Long.* 207° to 200°. *Lat.* 16° S.

22–28. Two dots, seen at 8.30 p.m. by Mr. Hadden on the 22nd. Twelve on the 25th, decreasing in number on the 28th.

May — GROUP 41. *Long.* 268°(?). *Lat.* 13° N.

18. Three very small spots not far from E. limb.

May — GROUP 42. *Long.* 195°. *Lat.* 18° N.

28. A small spot in the western hemisphere, observed only by Mr. Townsend.

May 30. — June 3. GROUP 43. *Long.* 158° to 152°. *Lat.* 19° S.

A stream of little spots, two with penumbra on June 1 and 2. Reduced to three on the 3rd.

June — GROUP 43A. *Long.* 105°. *Lat.* 0° to 2° N.

1–7. Two or three faint little spots on the 1st not far from the central meridian, increasing a little on the 5th. Near limb on the 7th.

June — GROUP 44. *Long.* 59°. *Lat.* 6° N.

1. A small spot near E. limb.

June — GROUP 45. *Long.* 68°. *Lat.* 12° S.

5–6. When first seen, a little pair not far from the central meridian.

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June — GROUP 46. *Long.* 0°. *Lat.* 19° S.
7. Two faint little spots. Possibly seen by Miss Brown on the 5th.

June — GROUP 47. *Long.* 332° to 324°. *Lat.* 13° to 16° N.
13. Four very small spots (observed by Mr. Hadden at 1.45 p.m., and probably a reappearance of a dot seen by him on the 7th).
14. Little change.
15. A stream, the final spot only penumbral.
16. Solitary, a new spot to the S.
17. About five small spots, N. and S. of each other.
18. Near W. limb.

June — GROUP 48. *Long.* 238° to 230°. *Lat.* 17° to 18° N.
16. A cluster of very small spots 46° E. of the central meridian.
17. Two little streams, parallel to each other.
18. In one stream, about 15 spots; a small spot 8° S. f.
19. No longer a stream, but a few spots widely separated, rather more S. f.
20. Fast fading at 6.30 p.m.

June — GROUP 49. *Long.* 170°. *Lat.* 10° S.
20–29. A small normal spot, about 20″ in major axis on the 24th, decreasing rapidly afterwards, and invisible when near W. limb. A very few small followers.

June — GROUP 50. *Long.* 160°. *Lat.* 12° S.
25–27. One or two faint spots f. 49.

June 25–July 1. — GROUP 51. *Long.* 86° to 78°. *Lat.* 5° to 7° S.
On the 25th a very small spot near E. limb; on the 28th three. (A veiled group closely f. was observed by Mr. Hadden on the 29th.)

June — GROUP 52. *Long.* 143°. *Lat.* 12° S.
27–29. One or two small spots following each other.

July. — GROUP 53. *Long.* 228° to 225°. *Lat.* 10° to 19° N.
15–17. A little cluster in the eastern hemisphere, in two sets, N. and S. o each other on the 16th; on the 17th one set only.

July. — GROUP 54. *Long.* 136° to 132°. *Lat.* 13° S.
19. A small spot near E. limb, with slight penumbra.
20. A smaller f.
21. Little change.
23. Both nearly equal, irregular.
24. More spots, three only with penumbra.
25. Fewer, in two sets. This group seems to have disappeared rather suddenly.

July. — GROUP 55. *Long.* 55° to 48°. *Lat.* 7° S.
29. A kite-shaped cluster of very small spots.
30. On the central meridian, more elongated, a little increase in area.
31. Two considerable spots, only dots between.

Aug.
1. Two pairs with very little penumbra, much more widely separated, no intermediates.
2. Fast decreasing, one spot p. two f. This group seems also to have vanished before reaching the limb.

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July. GROUP 56. *Long.* 21° to 15°. *Lat.* 12° to 14° S.
29. A small spot at some distance from E. limb.
30. A few more f.
31. Leading spot larger than the rest, which are small and more in a stream.
Aug.
1. Leader with three nuclei.
2. Ear-shaped penumbra almost confined to the S., about six nuclei, one of the f. larger.
3. More normal and fewer nuclei. The f. scattered.
4. Quite dispersed, one nearly normal spot f.
5. Three principal spots nearly in a line.

July. GROUP 57. *Long.* 335°. *Lat.* 11° N.
31. A small penumbra spot near E. limb, a smaller f.
Aug.
1. Nucleus double, a portion of penumbra detached.
2. Ear-shaped, nucleus single, more spots f.
3. Major axis 1′ of arc.
4. Larger, vertically inclined, tapering at the upper extremity.
5. Two penumbral extensions eastward.
6. Little change.
7. Nucleus bridged. Two penumbral patches detached.
8. Solitary.
9. Signs of disruption in nucleus.
10. Normal, smaller.
11. Penumbra wider on the f. side.

Aug. GROUP 58. *Long.* 48°. *Lat.* 11° N.?
1-2. A small nebulous spot in the eastern hemisphere.

Aug. GROUP 59. *Long.* 307° to 302°. *Lat.* 9° to 13° S.
2. A penumbral spot near E. limb with double nucleus.
3. A portion detached, major axis about 50″. Two spots f.
4. Compound, larger, detached portions appearing re-united, more f. spots, the two most easterly with slight penumbra.
5. Nucleus quadrangular.
7. Nucleus split up into oblong divisions.
8. Elongated, four distinct nuclei.
9. Drawn out length-wise in a carrot-like form, p. portion cleft. Major axis 1′ 30″, f. spots altered in form and position.
10. Decreasing, split in twain, each portion with elongated irregular nucleus.
11. More separated, each with two nuclei. At 10 a.m. the f. with surrounding penumbra; at 6 p.m. without any; the f. few and small.
12. Much foreshortened and reduced, f. spots in three sets.
13. One spot near limb. At 6.10 p.m. a mere dot on the edge.

Aug. GROUP 60. *Long.* 248° to 239°. *Lat.* 9° to 13° N.
11. A cluster of about six small spots at 10 a.m. More numerous at 6 p.m. with another more compact f.
12. At 8 a.m. a stream denser at the two extremities; near the central meridian. At 5 p.m. with two penumbral, medium-sized spots.
13. Two very compound spots, major axis of each 45″ with a few intermediates.
14. Leading spot breaking-up, the f. with singular barred nuclei. A new penumbral spot to the S. At 8.30 p.m. (Iowa) decreasing, the f. with the larger nucleus of the two; many dots between.
15. Slowly decreasing, both more normal.
16. Little change, outliers fast vanishing.
17. Still on the wane, the two spots nearly equal in area.
18. Near limb, the f. only visible.
19. Close to limb at 4 p.m.

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Aug. GROUP 61. *Long.* 236°. *Lat.* 10° S.

11–18. Two faint little spots on the 11th, a stream on the 12th. Final spot with slight penumbra on the 13th and 14th. Rapidly dying out afterwards and reduced to two dots on the 18th. Returned as Group 66.

Aug. GROUP 62. *Long.* 138°. *Lat.* 13° S.

21–23. A wide pair of very small spots.

Aug. GROUP 63. *Long.* 148° to 145°. *Lat.* 3° to 4° S.

22–24. Two pairs of small spots, widely separated. When near N. limb one only was observed.

Aug. GROUP 64. *Long.* 33° to 29°. *Lat.* 9° to 10° S.

26. A wide pair of penumbral spots on the central meridian.
27. Both with double nuclei.
28. Broken up and destitute of penumbra.

Aug. 26–Sept. 7. GROUP 65. *Long.* 339°. *Lat.* 9° N.

A normal spot varying but little throughout its course. In nearly the same position as 57.

Aug.

27. Penumbra wider on the f. side. Nucleus bridged in several places on the 28th, major axis about 50″.
31. A few outliers and two very small spots p. in long. 349°, lat. 7° to 8° N.

Sept.

1. When nearing N. limb smaller; faculæ closely surrounding on the 5th.

Sept. GROUP 66. *Long.* 244° to 228°. *Lat.* 11° to 16° S.

2. A large spot first observed by Mr. Hadden at 5 p.m. G.M.T., near E. limb. Penumbra to the N. and S., a little to the E., but none to the W. Six hours later more pronounced to the E. but still none to the W. Umbra appearing to protrude.
3. Nucleus large, black, and irregular, partly indented at the western edge by the influx of photospheric matter, two very small nuclei on the N. edge of the penumbra.
4. More indented to the W. A small spot f.
5. Nucleus divided, except a narrow isthmus, to the N., somewhat resembling a lintel and the two posts of a door. Many small followers.
6. A bright bridge, hooked at the end, extending across the nucleus, Mr. Wadmore describes it as seeming to stand up from the solar surface; f. spots in two clusters.
7. Three narrow bright bridges N. and S. dividing the nucleus into four parts. Two clusters of small spots f. Mr. Hadden reports that at 5.10 p.m. and 5.30 this spot and the region closely following was the centre of very active disturbance when observed with the spectroscope. At 7.10 it had nearly ceased.
8. On the central meridian, elongated and almost parallel to the equator; penumbra branching on the N. f. side. The two clusters increased and surrounded with penumbra.*
9. Major axis of large spot nearly 2′ of arc in length, or 48,000 miles, or $\frac{1}{15}$ of the solar diameter. Whole group over 170,000 miles. Bridges singularly arched, but not entirely dividing the nucleus. F. clusters with more space between the two. The f. with many little irregular nuclei surrounding a vacant space.
10. Nucleus tapering at the eastern extremity, penumbra torn at the edges; f. spots more separated and rapidly changing.

* A drawing in the "Journal," Vol. IX., No. 2.

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Sept. GROUP 66—*continued.*

11. Torn fragments of penumbra replaced by small spots. On this date Mr. Maw observed many interesting changes taking place in the nucleus, especially what he terms "veiled bridges." (*See* "Observatory," November 1898, No. 272.) F. spots again altered in form and position. Those at the rear in a semicircle.
12. Nucleus jagged and curving, with "black holes" visible in it. The f. spots decreasing, but the semicircle more pronounced.
13. Still very complex. Nucleus in two divisions.
14. Much foreshortened, penumbra spreading to the N. At 8.50 a.m. the f. spots quite distinct and rapidly decreasing in number. At 5.30 p.m. penumbra forming a singular loop, the smaller nuclei very indistinct, hardly more than one spot f. with its penumbra on the opposite (f. side) to what it was a.m.
15. At 11 a.m. two spots close to W. limb, the larger a mere line (probably the one which returned after rotation), the rearward spot with penumbra on the f. side.

Sept. GROUP 67. *Long.* 167° to 161°. *Lat.* 3° N.

11. Two small spots, observed by Mr. Hadden at 2.30 p.m.
13. A few more.
14. A curved stream, at 10.20, the first and last larger than the rest, but almost without penumbra. At 5.30 p.m. great increase, two compound spots, the intermediate almost gone. (On the meridian.)
15. Both spots nearly circular, the f. opening westward. Major axis about 30″.
16. The f. elongated, tapering to the S.W. Some outliers.
17. The p. normal; the f. broken up with no penumbra to the E.
18. The p. much reduced, the f. almost gone. No outliers.
19. One very small spot.

Sept. GROUP 68. *Long.* 174° to 169°. *Lat.* 12° S.

14. Two very small spots at 2 p.m. (not seen at 10.20 a.m.) A few more at 5.30, in two sets.
15. One spot p., a little pair f.
16. A stream, but no increase in area.
17. Many more, in two groups, hardly any penumbra.
18. The leading spot larger, with several small nuclei, fewer following.
19. Leader with two nuclei, the f. in a zigzag.
20. Tapering and broken up at the extremity. Six spots f.
21. Divided, four spots f.
22. Apparently reunited.
23. Decreasing. Two nuclei.
24. Penumbra fast disappearing. A new spot f.

Sept. GROUP 70. *Long.* 356°. *Lat.* 4° N.

23. A dot at 5 p.m. observed by Mr. Hadden.
24. A very small spot, a fainter at some distance s.p.
25. Dots only in two. (Possibly this may not be the same group.)
26. Three veiled spots.
27. Rather more conspicuous.
28. Hardly visible.

Sept. GROUP 71. *Long.* 317° to 311°. *Lat.* 11° to 13° N.

26. A single faint spot at 8.20 a.m., about 56° E. of central meridian. At 1.10 p.m. five.
27. Slightly increasing at 4.55 p.m.
28. A small penumbral spot with double nucleus. Dots streaming in front like a shower of sparks. (At 8 a.m.)
29. Immense increase in 24 hours, two considerable and very compound spots with numerous small nuclei and outliers adjacent.
30. Elongated, the two p. with penumbra on opposite sides, giving the whole a twisted appearance; rear spot normal.

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GROUP 71—*continued.*

Oct.
1. Leader normal, all slowly decreasing.
2. The p. divided, the f. broken up.
3. All more reduced.
4. Two spots, the p. normal, the f. very small.

Sept. GROUP 72. *Long.* 266° to 258°. *Lat.* 6° S.
28. A penumbral spot near E. limb with a smaller one f. At 1.15 two nuclei.
29. Penumbra on the f. side.
30. The f. spot decreasing.

Oct.
1. Signs of severance.
2. Major axis 40″. The f. with divided nucleus.
3. Broken up at the extremity
4. Nucleus jagged.
5. Elongated, the f. spot without penumbra.
6. A portion to the N. severed, the f. gone. Outliers s. f.
7. On the wane.
8. Very small.
9. Still decreasing.

Sept. GROUP 73. *Long.* 240°. *Lat.* 12° S.
29. Recorded at Greenwich, on this date, but not visible at 8.20 a.m. Second return of the large September group.
30. A large spot, nucleus bridged, penumbra chiefly to the N. and S.

Oct.
1. Three distinct nuclei nearly equal in area. (*See* illustration.)
2. Somewhat quadrangular, a small penumbral spot to the N. and a few much smaller f.
3. Three distinct nuclei, major axis 1′ 30″, breadth 1′; two penumbral spots to the N. Mr. Wadmore observing by direct vision remarks that one can hardly resist the idea that the spot is a cloud formation, and that in some places one is looking through a relatively thin film of mist.
4. Nuclei more irregular, penumbra with several fissures, f. spots all very small.
5. More subdivision, penumbra expanding to the E.
6. Very complex (see illustration) bridged and broken in every direction.
7. Still more complex. Prof. Pereira reports a curious and perfect instance of a black hole, and over it a bridge. (See illustration).
8. No radical change, still bridged and fissured, penumbra less extended eastward; no f. spots.
9. Penumbra opening westward.
10. Fast decreasing; the area not half what it was on the 8th.
11. Two principal nuclei.
12. Close to limb at 11.15.

Oct. GROUP 74. *Long.* 273°. *Lat.* 10° N.
4–7. A few very small spots in a stream N. p. Group 72.

Oct. GROUP 75. *Long.* 156° to 153°. *Lat.* 11° to 12° S.
7–12. When near E. limb a group of very small spots and dots, on the 9th 14° to 15° S. By the 10th an elongated penumbral spot, major axis 40″. Broken up into a number of fragments, chiefly nuclear. On the 11th a condensed cluster. On the 14th five dots only.

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Oct. GROUP 76. *Long.* 36°. *Lat.* 13° S.
18–20. A few insignificant spots.

Oct. GROUP 77. *Long.* 308° to 302°. *Lat.* 11° to 15° N.
22. A fine spot close to E. limb at 10.38. (Nearly the same position as Group 71, but long. less.
23. Very compound, in several closely contiguous sections, as if three or four spots had amalgamated; a large proportion of penumbra.
24. One principal spot; a smaller closely p. and another f.
25. No details.
26. No details.
27. At 3 p.m. much altered, the f. spot the largest of the three, the middle one being much reduced, a new one has appeared in advance.
28. More broken up; the new spot shattered. Group major axis 2′ 48″ or 75,810 miles, main spot 0·29 or 21,660 miles.
30. Decidedly reduced and elongated.
31. Dwindling.
Nov.
1. Still more reduced, the final spot quite fragmentary, the p. double.
2. One small spot only, with several dots.
3. Nearing W. limb.

Oct. GROUP 78. *Long.* 279°. *Lat.* 7° N.
26. A penumbral spot some distance from E. limb.
27. Two nuclei, a little irregular stream f.
28. No details.
30. Normal, solitary. 31 nebulous.
Nov.
1. Two nuclei. 2. Little change, only slight penumbra. 3 much reduced.
4. Small and faint.

Oct. GROUP 79. *Long.* 240°. *Lat.* 13° S.
28. A small spot near E. limb. (Recorded at Greenwich on the 27th.) (A third return of the large spot of Sept.)
30. Not more than 30″ in major axis, some scattered outliers, chiefly f.
31. Leader with a portion on the f. side, as if severed, outliers fewer.
Nov.
1. Only two outliers.
2. A scattered group of small spots.
3. Much decreased; nebulous, a similar spot 5° more S. in nearly the same long.
4. The southern spot faint.
5. Both decreasing.
6. Still on the wane; southern spot gone.
7. Only just visible.

Oct. GROUP 80. *Long.* 209° to 199°. *Lat.* 4° to 8° N.
31. A few spots near E. limb hardly perceptible, observed by Mr. Bartlett at 9.15, but not seen by Miss Brown at 8.10.
Nov.
1. Great increase, the leader A, compound, major axis 45″. The f. B, consisting of a few small spots.
2. A, with several irregular small nuclei. B, a compact cluster of fairly large spots with slight penumbra.
3. Both about 50″ in major axis, with many small nuclei and still very irregular.

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Nov. GROUP 80—*continued.*

4. Still increasing, A more regular but splitting across the centre, B with as many as seven principal nuclei.
5. On central meridian, A more subdivided, B breaking up.
6. Both expanding, an opening in centre of A, B closing up, with a large proportion of penumbra. Little spots in a row f. touching each other; many outliers.
7. Nucleus of A larger, especially the p. B a mass of fragments, major axis of A about 1′ 20″ of arc.
8. No details.
9. More normal but bridged; faculæ clinging to spot.
10. Two nuclei, faculæ more extensive.

Nov. GROUP 81. *Long.* 173° to 166°. *Lat.* 9° to 10° S.

1–9. One little spot. On 3rd, a cluster of very small spots which increased slightly in area, and formed two sets of spots by the 5th. On the 7th they formed a stream all with penumbra, and on the 9th were still visible though very faint.

Nov. GROUP 82. *Long.* 168° to 161°. *Lat.* 4° to 6° N.

5–13. A few spots in two compact little clusters, which formed a pair by the 6th; were normal on the 7th; the following spot breaking up on the 8th, only one small spot of the following portion remaining on the 11th.

Nov. GROUP 82A. *Long.* 178°. *Lat.* 17° S.

10. A small isolated spot.

Nov. GROUP 83. *Long.* 84° to 80°. *Lat.* 7° S.

11–16. Two little spots which have slight penumbra on following side, and some outliers on the 13th. On the 14th the spots are in a line, but little inclined to the equator, all without penumbra. On the 16th only three were visible.

Nov. GROUP 84. *Long.* 356°. *Lat.* 13° S.

18–26. A nuclear spot with axis not exceeding 20″, followed by a few small ones, in a stream on the 19th, reduced to one on the 22nd, and wholly disappeared when leader near limb on the 26th.

Nov. GROUP 85. *Long.* 213° to 209°. *Lat.* 5° N.

29-30. Two little spots widely separated, a cluster on the 30th. A return of Group 80.

Nov. 27–Dec. 8. GROUP 86. *Long.* 203°. *Lat.* 8° S.

Appeared as a penumbral spot near limb amid compact faculæ. On Nov. 29, normal, major axis 45″. On 30th a few faint outliers. On December 3rd was divided, and formed a close pair equal in area on the 4th, on the 7th was decreasing, and was much reduced by the 8th.

Dec. GROUP 87. *Long.* 131°. *Lat.* 13° S.

2–13. A spot 1′ of arc in major axis, which is nearly normal, but with an elongated nucleus by the 4th. On the 7th it began to be severed into two parts, the process being completed by the 8th. On the 9th it was changing rapidly, but was more condensed, composed of nuclei, with tongues and bridges. On the 10th the two portions were just joined by a penumbral thread. On the 11th was still more compact, with three nuclei, but again was severed when, much reduced, was nearing the limb.

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Dec. GROUP 88. *Long.* 289°. *Lat.* 7° N.
19–20. A scattered group of small spots.

Dec. GROUP 89. *Long.* 180° to 182°. *Lat.* 11° S.
28–31. Two faint spots, widely separated; on the 30th four; on the 31st, much developed in two sets.

Dec. GROUP 90. *Long.* 155°. *Lat.* 13° S.
29–30. A very small spot among bright faculæ.

Dec. GROUP 91. *Long.* 111°. *Lat.* 5° S.
31. A spot near E. limb with slight penumbra.

Published February 20, 1900.

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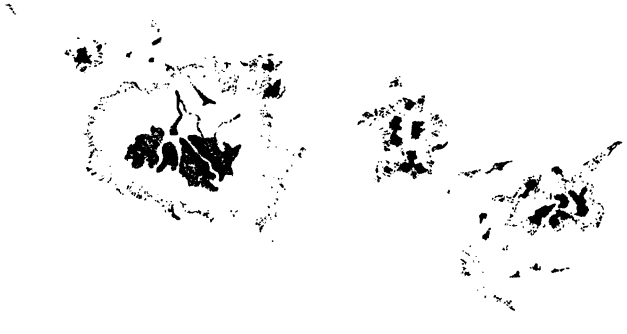
1898. Second and Third Appearance of Great September Group.

Sep.3. H.Corder, del.

Sep.7. 12. 50. T.H.Astbury, del.



Sep.8. 12.55. T.H.Astbury, del.

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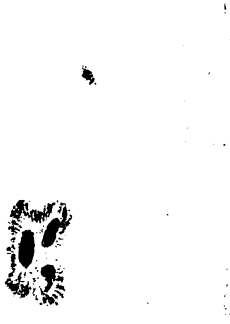
1898. Second and Third Appearance of Great September Group.

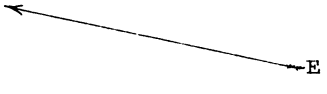
Sep. 11. 1.5. T. H. Astbury, del.

Sep. 12. 1.0 T. H. Astbury, del.



Oct. 1. H. Corder, del.

Oct. 11. J. de M. Pereira, del.



Oct. 6. J. de M. Pereira, del.

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Tailby & Price, lith.

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SECTION FOR
ASTRONOMICAL PHOTOGRAPHY.

DIRECTORS { JOSEPH LUNT, F.R.A.S., B.Sc.
R. WILDING, F.R.A.S.

REPORT OF THE SECTION, 1897-98.

Judged by the number of Members who expressed a willingness to co-operate in the work, the Section gave early promise of being a successful one. The Directors have, however, to confess to a feeling of disappointment that many have gone no further than this initial step, and have not as yet furnished samples of their work. Others apparently are still engaged in preliminary experiments with a view to making their equipment more perfect before commencing systematic work.

Those Members who so kindly undertook to do printing, enlarging, lantern-slide making, and the thorough examination and comparison of negatives, with a view to relieving those of the night workers who have limited leisure for such work, have not been kept so busy as the Directors had hoped.

In solar photography Mr. Newbegin deserves special mention as having given us a more or less continuous record of the telescopic appearance of the sun's surface, only broken by his disinterestedness in lending his admirable instrument for the purpose of eclipse observations in India.

His photographs have been exhibited on the screen from time to time at our monthly meetings as interesting solar disturbances manifested themselves, and they are so well known and appreciated by the Members that no further description of them is needed.

Dr. Smart has, from time to time, contributed photographs of individual sun-spot groups on a larger scale and has furnished us with additional detail to that shown on Mr. Newbegin's photographs.

In lunar photography, Mr. Offord, assisted by Mr. Dykes, has done good systematic work. He has given his results in the form of a paper published in our "Journal."

In planetary photography, Mr. Longbottom and Mr. Offord have made some interesting experiments, but the day for successful planetary photography has yet to come, and visual observations remain *facile princeps* in this class of work.

In stellar and nebular photography Messrs. Ellis, Longbottom, and Evans, and Prof. Naegamvala have given us valuable records, to which the Directors have added their quota. The Directors

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record with very deep regret the loss the Section has sustained by the untimely and sudden death of Mr. J. de Villiers, who was killed in the lamentable railway accident at Mosterthoek, South Africa, on August 16, 1898.

Mr. de Villiers purposed devoting himself to astronomical pursuits in his retirement at Sea Point, and had erected an observatory which must be regarded as on a magnificent scale for an amateur. The building was completed, and the transit instrument and photographic equatoreal were all but finished ready for shipment to the Cape, when he was so suddenly taken from us.

His death is the more to be regretted as his sphere of work would have been the southern skies, and no doubt, had he lived, the Members would have had good opportunities of seeing portrayed on the screen some of the wonders of the heavens which northern observers may never see.

List of Members and Contributors.

Names.	Locality.	Instrument.
Allen, A. C.	Folkestone	3½-in. refractor.
Antoniadi, E. M.	Juvisy, near Paris	——
Bacon, Rev. J.	Newbury	12-in. reflector, 4 1/10-in. refractor.
Bacon, Miss Gertrude	Newbury	12-in. reflector, 4 1/10-in. refractor.
Clapton, T., F.R.P.S.	Harlesden, N.W.	——
Clough, Chas. E.	Southport	9¼-in. reflector, 3½-in. P.L.*
Dykes, F. J.	Ealing	——
Ellis, H.	Potter's Bar	9-in. reflector, 80-in. focus.
Evans, F.	Chester	6-in. refractor, 5½-in portrait lens.
Evershed, J.	Kenley, Surrey	2¼-in. Prismatic camera.
Forsyth, H. C. B.	Macduff, N.B.	3-in. altazimuth refractor; 1½-in. lantern lens.
Freeman, A.	Hastings	10½-in. reflector, 2-in. guider.
London, W.	Woodbridge	15½-in. reflector.
Longbottom, F. W.	Chester	18½-in. reflector (altazimuth). 3-in. refractor, 2½ in. and 5½-in. P.L.
Lunt, J.	Cape of Good Hope	——
Maunder, E. W.	Lewisham, S.E.	——
Maunder, Mrs.	„	——
Maw, W. H.	Kensington, W. and Outwood, Surrey.	6-in. and 8-in. refractors, 8-in. single lens, 4½-in. P.L.
Moore, J.	Charlton	9-in. refractor.
Naegamvala, Prof. K. D.	Poona, India	16½-in. reflector.
Newbegin, G. J.	Norwich	9-in. and 4-in. refractors, 2-in. P.L.
Offord, J. M., F.R.M.S.	Ealing	12¼in. reflector, 3¾-in. refractor.
Smart, Dr. D.	London, S.E.	10-in. reflector.
Wilding, R.	Bartle, near Preston.	19-in. reflector, 5-in. P.L.

* P. L. = Portrait Lens.

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I.—The Sun.

Messrs. Maunder, Newbegin, Smart, and Allen have contributed photographs of the solar disk and special sun-spot groups. Mr. Newbegin has contributed by far the largest number of these, which form an admirable series. Dr. Smart has furnished 25 photographs, and Mr. A. C. Allen two experimental ones.

II.—The Moon.

Messrs. Offord, Longbottom, Newbegin, and Wilding have furnished more or less successful photographs of the surface of our satellite. Mr. Offord being *facile princeps* in this work, and having obtained most encouraging results considering that his are amateur efforts with amateur equipment.

Messrs. Smart, Moore, and Freeman have also contributed their experimental results in this field.

The more noteworthy of Mr. Offord's* photographs are given below. For further details of his equipment and methods *see* his paper "Journal of the British Astronomical Association," Vol. VIII., No. 5, p. 232).

Region.	Date.	Time.
	1896.	h m
Theophilus - - -	Aug. 27	11 45
Theophilus (smaller scale) -	„	11 30
	1897.	
Full moon - - -	Feb. 17	9 15
Gassendi - - -	Mar. 15	?
Aristarchus (showing also the Moon maiden).	„	10 20
Straight wall - - -	April 10	8 45
Plato Lunar Alps and Archimedes.	„	9 58

* Mr. Offord was often assisted by Mr. Dykes.

III.—The Lunar Eclipse of January 7, 1898.

Messrs. Longbottom and Smart are the only Members who have sent photographic records of this phenomenon.

Mr. Longbottom made 10 exposures with his 18½-inch Calver reflector, giving exposures of $\frac{1}{10}$th second with a stationery telescope. The focal length of his instrument is 10 feet 5 inches, and the scale of his photographs is nearly 2¼ inches to the lunar diameter. A print of one of these, taken at $11^h\ 52^m$, and sent with his return, is full of fine detail, and makes a capital record of the partial phase.

Dr. Smart's four photographs are an inch smaller in diameter, and not so successful as the last named.

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IV.—The Planets.

This field of work is certainly the most difficult and least profitable of any which the Members can take up. Even large well equipped observatories have not been able as yet to turn out photographs which, as regards planetary detail, are worthy the time and pains bestowed upon them, and therefore amateurs with small equipment should be discouraged from attempting work in this field. The time expended could be more profitably occupied with stars and nebulæ, unless, indeed, some of our more ambitious Members turn their attention to the photographic search for faint undiscovered satellites, and even this is a field where the large observatories are more than likely to anticipate the efforts of our Members.

Messrs. Offord and Longbottom are the only Members who have attempted planetary work. Venus, Jupiter, and Saturn have each received a share of attention.

V.—Comets.

We have not been favoured by the appearance of any bright comet. Through the kindness of Her Majesty's Astronomer at the Cape of Good Hope, one of the Directors of the Section is able to contribute his photograph of Comet Coddington, taken with the 13-in. astrographic telescope with an exposure of two hours. It appears merely as a small nebulous ball with a suspicion of a short fan-like tail or an eccentric condensation.

The photograph is useful merely as showing how the Members of this section may secure fairly accurate positions for objects of this class by submitting their photographs to careful measurement. The two ends of each star trail represent the relative positions of the neighbouring stars and the comet at the commencement and end of the exposure.

One can make a paper print from the negative; place a piece of paper underneath it and prick one end of all the trails and the nucleus of the comet with a fine needle, and so obtain *diagrams* of the position of the comet with respect to the stars in the same field. Of course the centre of the nucleus of the comet must be used for guiding and not the stars, which latter must be allowed to trail as the comet moves along amongst them.

Those Members possessed of large reflectors are recommended to attempt any comet which is bright enough to show up the wires of their guiding telescopes, and so allow of guiding with dark wires on the brighter background given by the nucleus.

VI.—Meteors.

Bad weather prevailed in England during the November meteor period, and no photographs have come to hand. Judged by the display at the Cape, where clear cloudless skies were vouched to us, the shower was a very poor one, and in no way came up to expectations.

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Through the kindness of Her Majesty's Astronomer at the Cape, a copy of a chance meteor caught on one of the chart plates of the International Survey, by Mr. C. Ray Woods, during the routine work, is included in our collection.

Chance meteors like this are by no means rare, and should be looked for on all negatives, and not confused with chance scratches.

VII.—Star Fields, Clusters, and Nebulæ.

This branch of work is one of the most fascinating and promising. The Members have secured a good number of negatives, many of them of excellent quality.

Messrs. Longbottom and Evans, Ellis, Naegamvala, and the Directors are the only ones who have made really serious efforts, The Directors regret that various circumstances have combined to make the first beginnings of this work rather tardy. There are still many instruments adapted for the work which, up to the present, have not been fully utilised by our Members for, no doubt, excellent reasons; but it is hoped that these may soon be pressed into the service, and that the preliminary experimental stage may soon give way to more constant and systematic efforts.

The English climate is by no means conducive to sustained regular work in this branch of astronomical photography. Who that has worked in it has not again and again adjusted his instrument and made every preparation for a good night's work, only to feel the keen disappointment of having to relinquish it on account of thick haze or denser clouds coming up to mar the clear sky which tempted him on during his preparations. Perhaps a short exposure has already been secured on an object requiring a long one when the "cease fire" has to be sounded to dodge a sudden rain squall. High winds and the dewing of object glasses account for still further wasted efforts. Whilst others have experienced the exasperating presence of beautifully clear and suitable skies on occasions when other more pressing engagements have called them elsewhere to leave their telescopes idle.

These factors apply of course to all branches of astronomical observation, but owing to the much longer time taken up in preparing an instrument for photographic work they apply most of all to those engaged in securing photographic records.

For the encouragement of those who are not possessed of driving clocks to their telescopes, Mr. Longbottom's hand-driven photographs are especially commended. His photographs were taken with a 3-in. Cooke equatoreal on a portable stand, which had to be carried in and out for each night's work, and his camera was only furnished with a Dallmeyer portrait lens of $2\frac{5}{8}$-in. aperture and $6\frac{1}{4}$-in. focus. The instrument was kept moving during the whole exposure by means of a hand slow-motion rod.

His photographs show an astonishing number or stars and great wealth of detail, and the driving is really admirable.

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His longest exposures were an hour and a half, which he says is all he is capable of at one sitting, and those who have tried it will readily endorse his opinion.

His results have been sufficient to encourage him to erect a solid equatoreal with a driving-clock, on which he has erected a 5½-in. Voigtlander portrait lens of 22½-in. focus. No doubt he will find this far less fatiguing, and we shall expect him to give us much longer exposures in future in consequence.

Mr. H. C. B. Forsyth, Macduff, N.B., has attempted an even more difficult feat, viz., stellar photography with an altazimuth! He has forwarded a print from one of his negatives of the constellation of Orion taken by means of a 1½-in. lantern lens, mounted on a 3-in. altazimuth refractor. Exposure 22 minutes. His enthusiasm is worthy a better equipment.

Hints to Members.

The following hints may be of use to those Members who are making their first experiments in astronomical photography, and as some may not be experienced photographers, some details of photographic procedure are added.

(1.) *Focussing*.—Never attempt to ascertain the best working focus of your object-glass by viewing a star image on a ground-glass screen.

Devote a whole night, or several nights if necessary, to this fundamental point, and make all your focussing experiments photographically.

Fix a scale on your instrument so that you can read changes of distance between lens and plate.

Having ascertained the approximate focus in the daytime by focussing a very distant object on the focussing screen, move the plate well within this point and expose a plate on the night sky in a region where there are a few bright stars.

Allow the camera to remain stationary and let a star image trail along the plate for some definite length of time, say, 2–5 min. Move the camera forward in R.A. until the star is seen in its original position in the guiding telescope, then move slightly in Dec^{n} and re-expose, say, at 5 mm. longer focus. Repeat the operation until 5 or 6 exposures have been made at plate distance intervals of 5 mm., and all at regularly increasing or diminishing Dec^{n} readings.

Let the last exposure be twice as long as the others in order that the longer trail will enable you to identify each exposure.

It will probably be found that the sharpest line is at a focus somewhere between the extreme readings.

If not, repeat the operation until it is.

This will give an approximate focus. Repeat the operation on another plate, changing the plate distance by single millimètres, this time, starting just within and ending just without the best focus found in the first trial. With longer focus instruments finally expose another plate about the best focus for the centre of the plate, changing the focus reading by half millimètres until the sharpest line is obtained. The separation of the two trails

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of some convenient double star is a good test of relative sharpness for the finer focussing.

Now expose on stars, with the clock driving the telescope, at three or four focus readings close to the best focus found from the trails, changing the Dec^{n} for the second and third, and the R.A. an equal angular distance for the fourth exposure.

The best all round results will, in most cases, be obtained by making a slight sacrifice of absolute sharpness at the centre of the plate in order to obtain a fair average sharpness over a larger area. The sharpest stars will then lie in a circular zone round the centre of the plate. Judgment must be used as to how much to sacrifice in the centre. The sacrifice should not be apparent at a glance, or it is overdone.

Area of good definition.—Above all things do not let your anxiety to include a large area lead you to produce a negative looking more like a photograph of a whirlpool than anything else. Nothing looks worse than a crowd of stars apparently racing round the outer regions of your picture. Place a circular or square diaphragm in front of your plate, to cut off all such objectionably distorted images (or mask out when reproducing) even if your photograph only covers a half-a-crown, and show all your photographs as enlargements from the original.

Keep a watchful eye that the sharpest region of your photographs remains where it was intended to be, and correct for seasonal changes of temperature, if necessary.

Backed plates.—Always use backed plates for long exposures or for regions containing bright stars. Plate-makers now supply plates ready backed. These save trouble. This is especially important for solar and lunar photographs. Unbacked plates give less crisp definition owing to halation. This is seen in solar photographs as a hazy ring round the sun's limb. The haze is really overspreading the whole photograph and masking contrasts. In stellar negatives the brighter stars show spurious ring nebulæ surrounding the images. These can be effectively got rid of by proper backing.

Guiding.—The best of clocks are not to be trusted for long. Constant watchfulness is required to keep the star image from straying off the guiding wires.

Flexure of the instrument.—Reflectors are especially liable to this, and long exposures should not be attempted without some means of correcting it.

The plan adopted by Mr. W. E. Wilson, of Darramona, Ireland, is an excellent one, and avoids piercing the centre of the large mirror. The slide of the plate holder is silvered on the side facing the mirror. and can be illuminated by red light. The plate is closed at intervals, the slide being pushed home to a stop. The star image is then viewed by a small telescope, and any straying of the image from the cross lines on the silvered surface can be detected and at once corrected.

The best place for the plate is in the centre of the tube, and not, by the use of a flat, at the side, unless an enlarging lens is employed.

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In developing your plate, do not let your anxiety to see what is coming out tempt you to flood the plate with an unnecessary amount of red light, which may not be so safe as you imagine. This will cause fogging, and spoil your negative.

Manipulate your plate before exposure in absolute darkness, if possible, and thoroughly test your dark-room illumination to see that an exposure of, say, 5 or 10 minutes to the light of your developing room causes no fog to appear on a test plate. Make sure that your telescopic camera is light tight. Time your development rather than *see* its progress, and only use a faint safe light momentarily towards the middle and end of development to make sure that no fogging is taking place.

Development.—There is no *best* developer. After becoming accustomed to use a particular developer which gives good clear plates, free from stain or fog, do not lightly discard it for a newer one, without careful comparative experiments.

The following is a good developer for star plates :—

Stock Solutions—

(*a.*) 1 oz. hydroquinone, 1 oz. eikonogen, add 20 ozs. of 20 per cent. sodium sulphite solution, and pour into 20 ozs. of hot water. Stir until all is dissolved, and keep in well-stoppered bottles.

(*b.*) 2½ ozs. 20 per cent. sodium carbonate solution (made from the crystalline salt), 2½ ozs. 20 per cent. potassium carbonate, add 15 ozs. water.

(*c.*) 10 per cent. potassium bromide solution. In use take 2 ozs. each of (*a*) and (*b*), add 4 ozs. of water and 20 minims of (*c*).

Always use freshly mixed developer, and renew your hypo-sulphite bath when it becomes stained.

In hot weather, or in hot climates, use an alum bath after the developer, but wash the plate well after alum and before fixing.

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LIST OF PHOTOGRAPHS RECEIVED.

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List of Photographs received.

Object.	Date.	Exposure Commenced.	Duration. Sidereal Time.	Observer.	Locality.	Instrument.		Remarks.
						Guider.	Camera.	
		h m	h m					
Cluster M 46, and Nebula Herschel IV., 39 Argûs.	1894, Feb. 24	6 2	1 30	Dr. Isaac Roberts, F.R.S.	Crowborough	—	20-in. reflector	"Knowledge," Aug. 1895, p. 182.
Spiral Nebula, M 74 Piscium.	1893, Dec. 9	1 7	3 40	,,	,,	—	,,	Sept. 1895, p. 207.
Elliptical Nebula, H I. 84 Comæ Berenicis.	1894, May 7	12 31	1 30	,,	,,	—	,,	,, ,,
Elliptical Nebula, M 65 Leonis.	,, Feb. 28	8 19	0 40	,,	,,	—	,,	,, ,,
Spiral Nebula, M 66 Leonis.	,, ,,	,,	,,	,,	,,	—	,,	,, ,,
Cluster, M 13 Herculis -	1895, June 15	16 42	0 5	,,	,,	—	,,	Oct. 1895, p. 232.
,, ,, -	,, May 28	14 51	1 0	,,	,,	—	,,	,, ,,
Nebula M 78, and H IV. 36 Orionis.	1894, Jan. 28	3 3	3 0	,,	,,	—	,,	Nov. 1895, p. 254.
Nebula near 15 Monocerotis.	1895, Feb. 13	4 20	,,	,,	,,	—	,,	Feb. 1896, p. 38.
Spiral Nebula, M 33 Trianguli.	,, Nov. 14	—	2 15	,,	,,	—	Cooke 5-in. lens	July 1896, p. 158.
Exterior Nebulosities surrounding the Pleiades.	1893, Dec. 6 and 8.	—	10 15	Prof. E. E. Barnard.	Lick Observatory, California.	—	Willard lens, 6-in. aperture.	"Knowledge," Dec. 1895, p. 281.

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Nebulosity round 15 Monocerotis.	1894, Feb. 1	—	3 0	,,	,,	—	,,	May 1896, p. 109.
Nebulosities near Antares and ν Scorpii.	1895, June 21–22.	—	7 30	,,	,,	—	,,	Sept. 1896, p. 205.
Nebula M 8 in Sagittarius	,, May 18–19.	—	2 40	Prof. K. D. Naegamvala.	Poona, India.	—	16½-in. reflector	*Aug. 1896, p. 183.
Great Nebula in Orion -	—	—	—	,,	,,	—	—	*See* "Nature," June 17, 1897, p. 153.
M 46 Cluster, and Nebula Herschel IV. 39 Argûs.	—	—	—	,,	,,	—	—	——
M 22 in Sagittarius -	—	—	—	,,	,,	—	—	——
M 46 and Hd VIII. 38 Argo. δ Canis Majoris region - Milky Way in Ophiuchi M 8 region, 2 overlapping fields. M 67 in Cancer - -	—	—	—	,,	,,	—	Small portrait lens.	No details received.
Pleiades - - -	1896, Nov.	—	1 0	Henry Ellis	Potters Bar	—	9-in. Reflector 80-in. Focus.	
Great Cluster in Perseus -	1897, Sept. 26	—	1 0	,,	,,	—	,,	
Orion Nebula - -	—	—	1 20	,,	,,	—	,,	
Praesepe - - -	1898, Mar. 11	—	0 35	,,	,,	—	—	
,, - - -	,, ,, 13	—	1 45	,,	,,	—	—	

* The photograph appearing in "Knowledge" is so reproduced that the wonderful detail of the original negative is altogether lost. Mr. Lunt made copies from the original negative in which the faint nebulosities are strongly brought out. For a description of the method employed *see* "Journal" British Astronomical Association, Vol. VII., No. 3, p. 132. The photograph of the Orion nebula was similarly treated.

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List of Photographs Received—*continued.*

Object.	Date.	Exposure Commenced.	Duration. Sidereal Time.	Observer.	Locality.	Instrument.		Remarks.
						Guider.	Camera.	
		h m	h m					
Gap in Milky Way in Serpens.	1898, Aug.	—	1 20	Henry Ellis	Potters Bar	—	—	
M. 13 in Hercules -	„ „	—	1 40	„	„	—	—	
M. 11 - - - -	—	—	2 0	„	„	—	—	
Constellation of Orion -	—	—	0 22	H. C. B. Forsyth	Macduff, N.B.	3-in. Refractor Altazimuth.	1½-in. Lantern lens.	Hand-guiding with altazimuth.
Orion's Belt and Nebula -	1897, Jan. 24	—	1 0	Messrs. Evans and Longbottom	Chester	6-in. Refractor	5½-in. Portrait lens.	
Region of γ Cassiopeiæ -	„ Feb. 27	—	2 0	„	„	„	2½-in. „ „	
ζ Serpentis region -	—	—	0 18	„	„	„	„ „ „	
τ Serpentis region - -	—	—	0 30	„	„	„	„ „ „	
Coma Berenices - -	„ Apr. 30	—	0 25	F. W. Longbottom.	„	3-in. Refractor	2⅝-in. „ „	Hand-driving.
Region of ε Virginis -	„ May 3	10 10	0 40	„	„	„	„ „ „	„ „
Milky Way round χ Cygni.	„ Aug. 27	10 0	1 0	„	„	„	„ „ „	„ „

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Great Nebula in Andromeda region.	„	Dec. 15	6 50	0 41	„	„	„	„ „ „	„ „
Pleiades - - -		—	—	1 30	G. J. Newbegin	Norwich	9-in. Refractor	2-in. Dallmeyer P.L. 7 in. focus.	Clock-driven.
Region of β and γ Ursæ Minoris.	„	Apr. 30	11 30	2 30	R. Wilding	Nr. Preston	6-in. Refractor	5-in. Portrait ens.	„ „
Orion Nebula - -	„	Mar. 23	—	1 55	„	„	„	19-in. Reflector	
ζ Orionis - - -	„	„ 25	—	3 0	„	„	„	„	7 patches of Nebula and 3 Nebulous stars.
Orion Nebula - -	„	Dec. 20	—	0 50	„	„	„	„	
Region of γ Cygni - -	„	Aug. 28	10 0	2 0	„	„	„	5-in. Portrait lens 26-in. focus.	
Pleiades - - -	„	Dec. 21	—	3 50	„	„	„	„	
γ Cassiopeiæ - -	„	Nov.	—	1 0	„	„	„	„	
„ - -	„	„	—	2 30	„	„	„	„	
β Andromedæ - -	„	„	—	2 0	„	„	„	„	
Orion's belt and Nebula -	„	Jan.	—	2 0	„	„	„	„	Several well-marked Nebulæ.
ζ Orionis - - -	„	Feb.	—	2 30	„	„	„	„	
Praesepe - - -	„	Mar. 20	—	2 0	„	„	„	„	
Coma Berenices - -	„	„ 21	—	2 0	„	„	„	„	7 Nebulæ shown.

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Photographs of Telescopes and Observatories.

Mr. Wilding's -	Observatory -	Bartle, nr. Preston.	Exterior.
„ - -	„ -	„ -	Interior.
Mr. Offord's - -	Reflector - -	"Run off" Hut, Ealing.	——
Mr. Evans' - -	Observatory -	Chester -	Exterior.
The late Mr. J. de Villiers'.	Observatory -	Sea Point, South Africa.	„
Dr. Smart's - -	Reflector and camera.	London -	——
„ - -	Camera detached	„ - -	——

Miss Gertrude Bacon, and Messrs. London and Clapton, have kindly undertaken to carry out printing, lantern slide making, enlarging and reducing from Members' negatives in cases where they have not the requisite leisure or appliances for the purpose. By some who have only the bare leisure for the actual night observing this kind offer will be much appreciated.

The Directors hope that this small beginning will mark the commencement of a prosperous and productive section in the near future, and that all the Members will quickly surmount their initial experimental difficulties and settle down to more regular work, and so give scope for more systematised efforts than can at present be put forth.

JOSEPH LUNT
R. WILDING } Directors.

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SECTION FOR THE OBSERVATION

OF

JUPITER.

DIRECTOR.—ARTHUR COTTAM, F.R.A.S.

EIGHTH REPORT OF THE SECTION.

REPORT OF THE APPARITION OF 1898 AND 1899.

PART 1.

INTRODUCTORY.

I have followed the plan adopted by my predecessor, of dividing this Memoir into five Parts. Part 1 is a general introduction; Part 2 a general account of disk observations; Part 3 includes notes upon, and tabular statements of, observations of transits of spots, &c.; Part 4 contains satellite observations; and Part 5 contains various observations made with reference to the colours and colour changes on the Planet during the apparition.

The following is a list of the Members of the Section up to date, with the usual particulars.

Name.	Locality.	No. of Drawings.	Instrument.
WM. ANDERSON, F.R.A.S.	Madeira	3	5-in. O.G.
E. M. ANTONIADI, F.R.A.S.	Juvisy	—	—
E. ATTKINS	Highgate	25	6·5 in spec.
E. G. AYLETT	Bredgar	—	—
Rev. J. BAIKIE, F.R.A.S.	Ancrum	—	—
G. BANASTER, F.R.A.S.	Tewkesbury	—	—
W. M. BAXTER	Edinburgh	—	—
SCRIVEN BOLTON	Leeds	3	$4\frac{1}{8}$-in. O.G.
LEO BRENNER	Lussinpiccolo	—	—
J. H. BRIDGER, Mus.B.	Farnborough	3	4-in. O.G.

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Name.	Locality.	No. of Drawings.	Instrument.
G. L. BROWN	Stirling	—	—
B. W. BUTTEMER	Godalming	—	—
R. E. CAMMELL, F.R.A.S.	Wokingham	—	—
H. Y. CHILDS	Portland	—	—
J. E. CLARK, B.A., B.Sc.	York	—	—
E. J. COPE	Malvern	—	—
H. CORDER	Bridgwater	—	—
ARTHUR COTTAM, F.R.A.S.	Watford	2	12½-in. spec.
Rev. Dr. CRAIG, B.A., F.R.A.S.	Londonderry	—	—
R. CROSS	Oxford	—	—
E. W. ELLERBECK, F.R.A.S.	Scarborough	—	—
HY. ELLIS, F.R.A.S.	Potter's Bar	—	—
E. ESSAM, F.R.A.S.	Billingboro'	—	—
J. EVERSHED, F.R.A.S.	Kenley	—	—
R. FALCON	Workington	—	—
Rev. T. H. FOULKES, M.A.	Malta	3 parts	10½-in. spec.
A. FREEMAN	Hastings	—	—
W. F. GALE, F.R.A.S.	Newcastle, N.S.W.	—	—
F. J. GARRARD	Louth	—	—
W. GOODACRE, F.R.A.S.	Crouch End	—	—
H. F. GRIFFITHS	Streatham	—	—
ED. HALL	Bjorneburg	—	—
W. J. HALL	Nantwich	2	4⅞-in. spec.
G. B. P. HALLOWES, F.R.A.S.	York	—	—
A. HENDERSON	Liverpool	—	—
E. R. HICKS	Kensington	—	—
Rev. R. S. HUTCHINGS, F.R.A.S.	Salisbury	—	—
W. H. IZZARD	Brentford	—	—
J. JACKSON	Blackpool	—	—
W. E. JACKSON, F.R.A.S.	Liverpool	—	—
Rev. S. J. JOHNSON, M.A., F.R.A.S.	Bridport	—	—
Rev. P. H. KEMPTHORNE, M.A., F.R.A.S.	Wellington College.	—	—
Rev. R. KILLIP, F.R.A.S.	St. Annes-on-Sea	9	5-in. O.G.
N. LATTEY	Cardiff	—	—
J. LUNT, B.Sc.	Ealing	—	—
HY. MACEWEN, F.R.A.S.	Glasgow	—	—
W. H. MAW, F.R.A.S.	Kensington	—	—
J. W. MEARES, F.R.A.S.	Calcutta	—	—
A. MEE, F.R.A.S.	Cardiff	—	—
F. K. MELLOR, F.R.A.S.	Huddersfield	—	—
Capt. P. B. MOLESWORTH, R.E., F.R.A.S.	Ceylon	2	12½-in. spec.
J. M. OFFORD, F.R.Met.S.	Ealing	—	—
J. ORR	Glasgow	—	—
Rev. J. D. PARKER, LL.D., F.R.A.S.	Stevenage	—	—
Dr. G. PATTERSON, M.A.	Ascot	—	—
Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.	Yeovil	4	9-in. spec.
J. PHILLIPS	Hereford	—	—
W. T. PRICE	Wellington	—	—
Rev. V. REID	Glasgow	—	—
C. ROBERTS, F.R.A.S.	Kensington	—	—
Dr. RYLE, M.A.	Brighton	4	2 1/10-in. O.G.

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Name.	Locality.	No. of Drawings.	Instruments.
W. C. STEWART - -	Clapton -	—	—
Dr. SMART, F.R.A.S. -	Bermondsey -	1	10-in. spec.
C. F. SMITH - - -	Edinburgh -	10	5¼-in. spec.
H. F. SMITH - - -	Luton - -	—	—
Rev. W. SWINDLEHURST -	Wickham, N.S.W.	—	—
C. A. TAYLOR - -	London -	—	—
H. J. TOWNSHEND - -	Leeds - -	9	10-in. spec.
J. M. WADMORE - -	Exmouth -	—	—
Rev. W. R. WAUGH, F.R.A.S.	Portland -	1	4·5-in. O.G.
Rev. L. A. WILLIAMS -	New Shoreham	—	—
A. STANLEY WILLIAMS, F.R.A.S.	Brighton -	—	—
H. WRIGHT - - -	Sidney, N.S.W.	3	8½-in. spec.
J. WYKES - - -	Birmingham -	—	—

Mr. Scriven Bolton, of Leeds, and Mr. F. J. Garrard, of Louth, have recently joined the Section. The former has contributed three drawings for the present Report.

The adopted nomenclature diagram has been inserted in the previous reports, and as the Members of the Section no doubt possess some, if not all, of the earlier reports, it appears unnecessary to insert it again in this.

Mr. Crommelin's Jupiter Tables published in the "Monthly Notices" of the Royal Astronomical Society are of great value to our Members.

The total number of drawings sent to the Director has been, from observers in Britain, 73, and from observers in other parts of the world 11, making a total of 84. Five further drawings were sent by Capt. Molesworth, but not for retention of the Association, and they have been returned to him.

PART 2.

It is hoped that the following condensed description of the principal features and characteristics of the markings on the planet, with the descriptions of the drawings representing the various sections, comprising 60° of longitude in each, will, with the drawings reproduced, sufficiently indicate the appearance of the planet during the apparition of 1898–99.

1. The equatorial zone has been brightly coloured, yellowish orange being the colour most frequently noted, and the narrow equatorial belt has been very frequently and easily visible during this apparition. Another feature that has been strongly marked has been the wisps crossing the zone between the two equatorial belts, which have been much more easily seen than is usually the

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case. Mr. Killip remarks that he does not remember ever to have noticed them so readily, their striking visibility appearing to him a remarkable feature of this apparition. The belt and wisps were specially visible during May and the early part of June, and are shown on numerous drawings by Capt. Molesworth, Messrs. Phillips, Killip, Attkins, and Townshend.

2. The S. equatorial belt has been the most strongly marked feature of the Planet, usually red, often a chocolate red, or mahogany colour. The belt continues broadly double, but the narrow light rift dividing it into two portions has not been so continuous as last year. The S. edge of the belt has been dark and uniform, and the two shoulders of the red spot bay have been the only marked points. There have been numerous dark spots on the scalloped northern edge, often in juxtaposition with the brilliant white spots on the southern edge of the equatorial zone. The Great Red Spot is still a pale grey, and but rarely clearly visible.

3. The N. equatorial belt has been broader than last year, nearly if not quite as broad as the S. equatorial belt, and full of interesting detail. The estimation of its colour has varied considerably. Capt. Molesworth, at Trincomali, describes it as purplish grey rather ruddier than the S. equatorial belt. Observers in England have noticed it as greenish grey, but a few represent it as reddish. On the N. edge of the belt there has been a series of white notches, and white spots of a similar character on the belt itself. Most of the drawings show these markings.

4. The S. temperate band has not been a conspicuous feature. It is shown on almost all the drawings as a straight line merely.

5. The N. temperate band has been exceedingly faint, and it is not shown at all on many of the drawings.

6. The two tropical zones have both been well marked, white, but the southern zone decidedly the whiter, but the light spots less numerous and not so distinct as last year.

7. The N.N. and S.S. temperate bands have been very faint. They are shown on Capt. Molesworth's drawings, but on hardly any others.

8. The two polar regions have been featureless, but different in colour, the southern brownish, the northern a bluish grey.

The entire date range of the drawings is from February 26 to June 16, 1899.

The general descriptions have been divided, as heretofore, into six sections, each embracing 60° of longitude.

Section I., longitude 0° *to* 60°.—There are 20 drawings in this section, the greater part of which are comparable. The red spot bay is shown in all, and in every case the following shoulder is darker. The spot itself is shown in three drawings only. Messrs. Molesworth and Phillips in one drawing each represent

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it as a grey colour, but the Rev. T. H. Foulkes, at Madeira, sends a drawing of it, and describes the colour as a "very faint washed-out red." The S. equatorial belt is shown as duplex in the portion preceding the bay in six drawings, and in the following portion in four; its colour the reddest and strongest marking on the disk. The N. equatorial belt is shown as fainter and greyer, but generally of nearly the same breadth as the S. belt. The S. tropical zone and temperate band are shown in all the drawings, and the corresponding N. zone and band as well.

Messrs. Molesworth, Phillips, Killip, Townshend, Smart, Attkins, Anderson, Charles F. Smith, Hall, Ryle, Bolton, Foulkes, and the Director contribute to this section.

Section II., longitudes from 60° *to* 120°.—There are 13 drawings in this section, mostly comparable. The general features are shown generally as described in the previous section, but the N. equatorial belt is shown duplex in almost all the drawings, and diversified with a variety of light markings. The equatorial zone is generally shown yellow or reddish yellow, and Messrs. Anderson and Smith show the faint equatorial band.

Messrs. Attkins, Bridger, Anderson, Townshend, Ryle, Killip, and Smith contribute to this section.

Section III., longitudes 121° *to* 180°.—There are 10 drawings in this section, in most of which the S. equatorial belt is shown as duplex, and a large white spot, with, in some drawings, other smaller light markings on its northern edge. Mr. Attkins, in three of his drawings, shows the equatorial band, in two of them extending from limb to limb; and Mr. Phillips, on one of his drawings, shows it in the same way, and with a slight thickening at the preceding end. In this section the N. tropical band is shown as the broadest and lightest portion of the disk.

Messrs. Attkins, Bridger, Townshend, Hall, Phillips, Smith, Killip, and Ryle have sent drawings of this section.

Section IV., longitudes 181° *to* 240°.—There are 15 drawings of this section, all of them comparable. All show the S. equatorial belt duplex from limb to limb, and most show conspicuous white markings on its northern edge with dark spots between them, from which wisps cross the equatorial zone at various angles. The equatorial band is shown on only one drawing by Mr. Killip. And in this section, as in the last, the N. tropical band is a prominent feature.

Messrs. Attkins, Killip, Smith, Waugh, and Phillips contribute drawings of this section.

Section V., longitudes 241° *to* 300°.—There are 14 drawings of this section. The S. equatorial belt is shown duplex in all the drawings, with, as in the last section, light and dark spots on its northern edge and wisps from the latter. In eight of the drawings the equatorial band is distinctly shown on the reddish

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equatorial zone. The N. equatorial belt is shown broad and diversified, with light spots and markings. The S. temperate band is shown on nearly all the drawings as duplex, and the S. temperate band broader and more distinct than in the preceding sections.

Messrs. Attkins, Townshend, Bolton, Killip, Phillips, Bridger, and Wright contribute to this section.

Section VI., longitudes 301° *to* 360°.—There are eight drawings of this section, six of which agree in showing a large and prominent white spot on the northern edge of the N. equatorial belt, and another, but less conspicuous, on the northern edge of the S. equatorial belt. In other respects the drawings are not easily comparable, and they show no other well-defined features.

Messrs. Bolton, Townshend, Attkins, Smith, and Wright contribute drawings of this section.

Capt. Molesworth has sent five drawings besides the two for the Album, which have been returned to him. They are in accordance with drawings by other Members of similar longitudes, and have not been included in the above descriptions.

Of the drawings received, 12 have been selected for reproduction in this Memoir. They have been chosen with a view to showing as far as possible the characteristics of the markings in each section described above.

It has been considered sufficient that the drawings reproduced should speak for themselves without giving a written description. The whole of the drawings can be referred to in the Album for 1898–99.

PART 3.

TRANSITS OF SPOTS, &c.

Capt. Molesworth and the Rev. T. E. R. Phillips have given special attention to the transits of dark and white spots on the disk, and their rotation periods.

Capt. Molesworth's notes and observations are very elaborate and complete, and are much too copious for entire reproduction. It is not at all an easy matter to do justice to his work in an abstract of it. He gives 38 folio pages of observations of 138 spots in 15 different belts and zones, extending from 31st May to 22nd September, followed by 44 pages of details of the various spots observed, and summaries and analyses of results.

The following is one of his tables showing the mean rotation periods deduced from his transit observations. His first column, giving the zones, has been omitted as he has a special method of lettering them, but the second column, giving approximate

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latitude, and the column of "Description of Objects," will make the table sufficiently clear:—

MEAN ROTATION PERIOD OF SPOTS DEDUCED FROM TRANSIT OBSERVATIONS.

Approximate Latitude.	Number of Objects.	Description of Objects.	Average Drift.	Average Rotation Period.	Average Number of Transits.	Average Number of elapsed Rotations.
			°	h m s		
−40	3	Dark spots in S. temperate belt.	−·3509	9 55 05·6	3·33	105
−33	5	White spots in S. temperate zone.	−·2493	9 55 15·87	3·40	109
−26	15	Dark spots and streaks in S. tropical belt.	−·2470	9 55 16·01	5·46	167
−8 to −15	4	Markings in neighbourhood of Red Spot Bay.	+·0176	9 55 41·98	14·25	248
− 8	5	White spots in centre of S. equatorial belt.	Not taken.	9 54 44·56	3·80	137
− 6	23	Dark spots in N. edge of S. equatorial belt.	*−·0523	9 50 24·85	7·30	204
− 5	19	White spots in S. edge of equatorial zone.	*−·0925	9 50 20·89	5·16	181
± 0	8	Dark spots and streaks in equatorial band.	*−·0006	9 50 29·94	3·39	159
+ 6	4	White spots in N. edge of equatorial zone.	*−·0032	9 50 29·68	4·25	128
+ 7	10	Dark spots at S. edge of N. equatorial belt.	−·2042	9 55 20·26	4·30	154
+10	10	Dark and white spots, centre of N. equatorial belt.	−·0565	9 55 35·01	5·00	183
+12	14	Dark spots at N. edge, N. equatorial belt.	−·1006	9 55 30·64	6·57	179
+12	7	White notches in N. edge, N. equatorial belt.	−·1947	9 55 31·22	6·86	155
+20	6	Dark streaks in N. tropical zone.	+·2598	9 56 06·41	4·50	123
+28	5	Dark streaks in N. temperate belt.	+·3718	9 56 17·54	4·40	173
Total -	138				5·70	170

The drifts marked thus * refer to Marth's System i., the rest to Marth's System ii.

This Table, Capt. Molesworth remarks, contains the gist of all the observations for longitude recorded in the book containing all these observations. Out of more than 1,100 recorded transits, nearly 800 (or about two thirds) have been utilised for the determination of the rotation periods of 138 spots, giving an average of 5·70 transits extending over 170 rotations of each spot.

The book also contains 20 diagrams giving graphical representations of the various tables.

In his remarks upon the currents of the S. equatorial belt, he says:—"There is a great difference in the periods of the currents "extending over the S. equatorial belt. This is accentuated "in the narrow isthmus between the Red Spot Bay and the "equatorial zone. At the centre of the bay the breadth of the "belt is narrowed down to almost nothing; but the N. edge of "this narrow portion has a period of $9^h\ 50^m\ 24^s{\cdot}8$, while the "S. edge has a period of $9^h\ 55^m\ 41^s{\cdot}9$.

"From the motion of the white spots in the centre of the "S. equatorial belt, I am inclined to adopt a mean period of "$\pm 9^h\ 54^m\ 44^s$ for these spots, which is intermediate between

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" that of the Red Spot Bay and the spots in the N. edge of the " belt. I have traced these white spots right up to the following " shoulder, but have never seen them in the narrow isthmus " between the Red Spot Bay and the equatorial zone. They " would naturally be invisible in the bright double portion of the " belt preceding the Red Spot Bay, but can once more be traced " at the preceding end of the double portion. At this point the " more luminous centre of the belt seems to have a continuous " motion in a preceding direction. Presently a faint wisp moves " across near the preceding end, cutting off a circular white spot, " which rapidly increases its distance from the double portion, " and sets off down the centre of the belt as a separate spot.

" The question is, what becomes of these white spots when " their motion brings them to the following shoulder? They do " not, I think, pass *over* the shoulder; as I have never seen the " latter notched, as it would be, by the passage of a white spot. " They do not pass *round* the isthmus, or if they do they are " invisible during the passage. They cannot be absorbed, as " they re-appear at the other end of the double portion preceding " the red spot.

" The only alternative seems to be that these white spots pass " *under* the following shoulder, and probably under the Red Spot " itself. But this involves two very curious points:—First, the " existence of two absolutely distinct currents in the Jovian " atmosphere superimposed one on the other; and secondly, the " existence of a comparatively rapid current under the Red Spot, " which has hitherto been looked upon, from its permanence, as " the marking which is most likely to represent the actual motion " of the body of the planet. The question is a most interesting one, " and the motion of these spots should be most carefully studied."

Captain Molesworth discusses the question of the relative levels of the various markings, and states his impression that the darker markings are at a relatively higher level than the light ones. He concludes, " A careful consideration of the equatorial zone and " equatorial band tends to confirm the impression that the darker " markings are at a relatively higher level. The delicate wisps " would be very difficult to explain if the contrary was the case, " and the rapid changes in their inclination to the equatorial " belts would imply enormous movements in the brighter matter " of the equatorial zone."

As regards the Great Red Spot, Captain Molesworth remarks that it is very faint indeed, but still visible. It appears as the faintest possible grey stain with no trace of red. A consideration of the longitude observations seems to show that the breadth of the Red Spot Bay from shoulder to shoulder has decidedly increased. He has taken observations of the longitudes of three points PS the preceding shoulder, RS the centre at the northern edge of the Red Spot Bay, and FS the following shoulder.

The longitudes of these three spots at various periods are given as follows:—

	PS	RS	FS
	°	°	°
June 1898 - -	5	25	42
June 1899 - -	19·5	36·5	55
September 1899 -	19·5	39	62

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The width of the bay was, therefore, 37·0° in June 1898; 35·5° in June 1899; but had increased to 42·5° in September 1899.

Comparing the results of the 1899 observations with those of the previous year, the mean rotation periods of the three points come out as follows:—

Spot.	Inclusive Dates.	Shift in Longitude.	Number of Rotations.	Mean Rotation Period.
		°		h m s
PS	April 4, 1898, to September 17, 1899.	13·62	1286	9 55 41·68
RS	April 2, 1898, to September 22, 1899.	18·73	1300	9 55 42·05
FS	March 26, 1898, to September 22, 1899.	20·90	1317	9 55 42·21

From this it will be seen that the motion of RS, which he thinks fairly represents that of the Great Red Spot, has practically remained constant since April 1898, its period being almost exactly $9^h\ 55^m\ 42^s{\cdot}0$.

The Rev. T. E. R. Phillips, of Yeovil, whose observations of transits of spots are next to Captain Molesworth's—the most numerous,—has arrived at the same rotation period for the Great Red Spot.

The following is the summary of his observations which he has furnished.

ROTATION PERIOD OF THE RED SPOT IN 1899.

A considerable number of transits of this remarkable object, and of the well-known hollow in the S. equatorial belt were secured between the beginning of January and the early part of August.

The mean period worked out as—

$$9^h\ 55^m\ 42^s{\cdot}1,$$

but the rate of motion was perceptibly quicker than this during the early part of the apparition. The acceleration of velocity, doubtless, commenced during the autumn of 1898, as at the beginning of January 1899 the longitude of the spot was about 4° less than that computed according to its rate of motion during the previous apparition.

The increased velocity thus indicated was maintained at the beginning of 1899, the rotation period at this time differing but slightly from that of the zero meridian of System II. (Mr. Crommelin's Ephemeris).

ROTATION PERIOD OF THE GREAT EQUATORIAL CURRENT IN 1899.

An immense amount of detail was visible in the equatorial regions of the planet during the apparition of 1899, and numerous observations were made at Yeovil with the object of determining the present velocity of the surface material in this latitude.

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Thirty-four spots at or close to the N. edge of S. equatorial belt, and 21 at the S. edge of the N. equatorial belt (which had greatly developed since the appariton of 1898) were sufficiently well observed to enable their rotation periods to be deduced. In a few instances the matter of correct identification of S. equatorial spots presented some difficulty, as the spots at times were very erratic in their movements, but it is believed that the mean results arrived at are to be relied on as being very near the truth.

—	Number of Spots observed.	Rotation Period.
		h m s
Spots at N. edge of S. equatorial belt -	34	9 50 24·66
Spots at S. edge of N. equatorial belt -	21	9 50 26·22
The corresponding values in 1898 were :—		
Spots at N. edge of S. equatorial belt -	19	9 50 24·2
Spots at S. edge of N. equatorial belt -	3	9 50 24·5

The following is a table of the individual spots observed during the apparition of 1899.

W = white spot. D = dark spot.

SPOTS AT N. EDGE OF S. EQUATORIAL BELT.

No.	W. or D. Spot.	Interval between First and Last Observations.	Approximate λ on May 1st. System I.	Rotation Period.	Remarks.
		Days.	°	h m s	
1	W.	194	359	9 50 24·7	17 observations. Motion erratic.
2	D.	139	9	9 50 24·8	10 observations.
3	W.	132	18	9 50 22·8	Only 6 observations, but identity pretty certain.
4	D.	203	27	9 50 20·9	8 observations.
5	W.	203	33	9 50 21·5	11 observations.
6	D.	110	46	9 50 22·9	7 observations.
7	W.	69	—	9 50 22·0	Spot apparently not formed till middle of May.
8	D.	182	52	9 50 25·7	11 observations.
9	W.	182	74	9 50 26·2	15 observations.
10	D.	90	89	9 50 28·1	14 observations.
11	W.	55	98	9 50 26·7	6 observations.
12	D.	55	109	9 50 27·2	Few observations, but identification certain.
13	W.	162	120	9 50 24·3	12 observations.
14	D.	194	131	9 50 25·3	13 observations.
15	W.	194	140	9 50 26·2	7 observations.
16	D.	96	148	9 50 30·4	Not seen till beginning of May.

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No.	W. or D. Spot.	Interval between First and Last Observations.	Approximate λ on May 1st. System I.	Rotation Period.	Remarks.
		Days.	°	h m s	
17	W.	164	155	9 50 29·7	Not very well observed.
18	D.	219	170	9 50 29·6	13 observations.
19	W.	109	—	9 50 25·9	Not seen after end of April.
20	D.	79	—	9 50 31·8	Not seen after end of March.
21	W.	107	198	9 50 24·0	Few observations. Spot vague and faint.
22	D.	111	208	9 50 27·4	7 observations.
23	W.	194	221	9 50 23·1	14 observations.
24	D.	212	230	9 50 22·8	27 observations.
25	W.	173	243	9 50 22·8	22 observations.
26	D.	85	255	9 50 19·2	9 observations.
27	W.	97	265	9 50 18·6	10 observations.
28	D.	173	274	9 50 25·1	23 observations.
29	W.	139	290	9 50 23·3	21 observations. Exceedingly brilliant, especially about April 10.
30	D.	111	301	9 50 21·6	21 observations.
31	W.	111	319	9 50 19·2	17 observations.
32	D.	187	330	0 50 25·2	16 observations.
33	W.	48	342	9 50 23·0	6 observations.*
34	D.	47	349	9 50 26·1	5 observations.*

* These spots apparently developed at the end of April.

SPOTS AT S. EDGE OF N. EQUATORIAL BELT.

1	D.	116	346	9 50 20·4	7 observations.
2	W.	60	8	9 50 30·4	Few observations, but identity certain.
3	D.	30	—	9 50 17·2	Not observed till May 22nd.
4	W.	71	36	9 50 33·4	Only 3 observations.
5	D.	64	57	9 50 29·1	8 observations.
6	W.	69	69	9 50 29·1	6 observations.
7	D.	74	80	9 50 28·9	5 observations.
8	W.	70	99	9 50 21·4	9 observations. Bright.
9	D.	69	111	9 50 28·6	7 observations.
10	D.	53	150	9 50 26·9	Only 4 observations.
11	D.	60	182	9 50 22·4	5 observations.
12	W.	55	194	9 50 24·7	7 observations.
13	D.	68	203	9 50 24·7	Only 4 observations.
14	D.	90	214	9 50 24·4	6 observations.
15	D.	70	230	9 50 24·8	Only 3 observations, but identification pretty certain.
16	W.	64	248	9 50 27·3	9 observations.
17	D.	171	262	9 50 26·0	11 observations. Very dark.
18	W	44	274	9 50 23·7	6 observations.
19	D.	95	295	9 50 31·4	10 observations.
20	W.	68	312	9 50 30·8	6 observations.
21	D.	30	324	9 50 25·2	Only 3 observations.

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Mr. Walter J. Hall, of Nantwich, has furnished the following Tables of Spot Transits observed by him :—

1899.

SPOT TRANSIT, TABLE NO. 1.

The "Bay" of the Great Red Spot.

Date.	G.M.T.	Wt.	λ System II.	Remarks.
	h m		°	
Apr. 17 -	10 12	1	50·0	*f* end of "bay."
May 4 -	8 47	1	35·4	Middle "
" 4 -	9 13	2	51·1	*f* end "
" 6 -	9 56	1	17·8	*p* end "
" 6 -	10 19	est.	31·7	Middle "
" 6 -	10 50	1	50·4	*f* end "
" 11 -	9 58	est.	50·9	*f* end "
" 18 -	9 45	est.	15·4	*p* end "
" 18 -	10 45	est.	51·7	*f* end "
" 23 -	9 2	1	21·2	*p* end "
" 23 -	9 24	est.	34·5	Middle "
" 23 -	9 48	1	49·0	*f* end "
" 30 -	10 12	est.	35·6	Middle "
" 30 -	10 37	1	50·7	*f* end "
June 6 -	10 28	1	17·2	*p* end "
" 16 -	9 40	1	50·7	*f* end "

Rotation Period, $9^h\ 55^m\ 40^s{\cdot}6$. No change in rate.

1899.

SPOT TRANSIT, TABLE NO. 2.

Light Spot overlying S. Equatorial Belt.

May 6 -	9 26	1	0·3	Very prominent overlying white spot.
" 6 -	9 33	1	4·5	*f* end of same.
June 6 -	10 0	est.	0·3	

Rotation Period, normal, viz., $9^h\ 55^m\ 40^s{\cdot}6$.

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1899.

SPOT TRANSIT, TABLE No. 3.

Dark Spot on N. Side of S. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m			
Apr. 22 -	12 13	1	6°5	A prominent indentation in equatorial zone.
May 22 -	10 30	est.	3·6	
„ 29 -	9 57	1	9·1	
„ 31 -	11 10	1	9·4	Dark rift seen from this spot across the equatorial zone to spot No. 4.

Rotation Period, $9^h\ 50^m\ 33^s\cdot1$.

1899.

SPOT TRANSIT, TABLE No. 4.

Dark Spot on S. Side of N. Equatorial Belt.

May 31 -	11 30	est.	21·6	A rift from this spot crosses the equatorial zone to spot No. 3.
June 5 -	9 35	est.	21·0	

Rotation Period, $9^h\ 50^m\ 25^s\cdot1$.

1899.

SPOT TRANSIT, TABLE No. 5.

Dark Spot on N. Side of S. Equatorial Zone.

Mar. 18 -	12 20	1	239·3	
May 3 -	10 21	est.	236·1	

Rotation Period, $9^h\ 50^m\ 27^s\cdot2$.

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4. 1899.

SPOT TRANSIT, TABLE NO. 6.

Dark Spot on S. Side of N. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m		°	
Mar. 18 -	13 0	1	263·7	
Apr. 17 -	11 17	1	261·8	

Rotation Period, $9^h\ 50^m\ 27^s\cdot5$.

4. 1899.

SPOT TRANSIT, TABLE NO. 7.

Dark Spot on N. Side of S. Equatorial Belt.

May 3 -	11 21	2	272·7	
June 2 -	9 35	est.	267·1	

Rotation Period, $9^h\ 50^m\ 22^s\cdot5$.

4. 1899.

SPOT TRANSIT, TABLE NO. 8.

Light Spot on N. Side of S. Equatorial Belt.

Apr. 22 -	10 22	1	298·2	Large white spot.
May 3 -	11 31	1	278·7	*p* end.
„ 3 -	11 52	1	291·6	Middle.
„ 3 -	12 10	1	302·5	*f* end.
„ 31 -	8 50	est.	283·7	
June 2 -	9 55	est.	279·2	

Rotation Period, $9^h\ 50^m\ 12^s\cdot7$.

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2. 1899.

SPOT TRANSIT, TABLE NO. 9.

Dark Spot on N. Side of S. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m		°	
May 6 -	9 5	1	303·8	
„ 31 -	9 8	est.	294·7	Dark rift n.f. to N. equatorial belt.

Rotation Period, $9^h\ 50^m\ 15^s\cdot4$.

2. 1899.

SPOT TRANSIT, TABLE NO. 10.

Dark Spot on S. Side of N. Equatorial Belt.

Feb. 11 -	19 22	—	7·6	T. E. R Phillips in "E.M.," May 5, p. 267.
Mar. 20 -	16 45	—	357·2	
Apr. 22 -	11 46	1	349·5	
May 6 -	10 8	1	342·2	

Rotation Period, $9^h\ 50^m\ 18^s\cdot2$.

2. 1899.

SPOT TRANSIT, TABLE NO. 11.

Light Spot on S. Side of Equatorial Zone.

Apr. 22 -	11 53	1	354·0	
June 14 -	9 4	1	343·2	

Rotation Period, $9^h\ 50^m\ 21^s\cdot6$.

2. 1899.

SPOT TRANSIT, TABLE NO. 12.

Light Spot on Equatorial Zone.

Apr. 22 -	12 1	1	359·2	
May 22 -	10 15	1	354·6	Large white spot extending threequarters the way across the zone.

Rotation Period, $9^h\ 50^m\ 23^s\cdot8$.

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1899.

SUMMARY OF ROTATION PERIODS OF SPOTS.

Spot No.	Kind.	Rots.	h	m	s
1	G.R.S. "Bay"	145	9	55	40·6
2	Light	75	9	55	40·6
	Equatorial Current.				
3	Dark	95	9	50	33·1
4	,,	12	9	50	25·1
5	,,	112	9	50	27·2
6	,,	73	9	50	27·5
7	,,	73	9	50	22·5
8	Light	100	9	50	12·7
9	Dark	61	9	50	15·4
10	,,	204	9	50	18·2
11	Light	129	9	50	21·6
12	,,	73	9	50	23·8

Mean for the Equatorial Current, $9^h\ 50^m\ 22^s{\cdot}7$.

Lindum House,
Nantwich.

WALTER J. HALL.

The attention of the Members of the Section is directed to two papers that have recently been printed in the "Monthly Notices" of the Royal Astronomical Society; one by the Rev. T. E. R. Phillips on "The Equatorial Currents of Jupiter in 1899," Vol. XL., p. 210, and the other by Mr. G. W. Hough, Director of the Dearborn Observatory, Evanston, U.S.A., "Observations on the Spots and Markings on the Planet Jupiter," made at that Observatory, Vol. XL., p. 546. This paper relates to observations made during a period of 20 years, and Mr. Hough's "Conclusions" at the end of the paper deserve careful study.

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PART 4.

SATELLITE OBSERVATIONS.

The satellite observations are less numerous than usual, probably owing to the unfavourable position of the planet. None have been received from observers at the Antipodes, whose opportunities have probably been greater than ours. The fullest returns are those of Capt. Molesworth, whose station in the clear air of Ceylon, and whose large telescope, have enabled him to do some excellent work in this department as usual. Two other observers have sent statements—the Rev. Theodore E. R. Phillips, Yeovil, and Mr. J. H. Bridger, Farnborough.

The following tabular statement combines the observations of the three, and the observations of each are distinguished by the initial letters M., P., and B. respectively.

PHENOMENA OF JUPITER'S SATELLITES.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
Apr. 4	II. Tr. E.	External contact.	13 53 0	13 54 0	P.	
Apr. 21	I. Sh. I.	First seen	11 5 0	11 7 0	P.	
—	—	External contact.	11 11 0	11 13 0	P.	
May 6	II. Tr. I.	Do.	9 43 0	9 42 0	P.	
May 7	I. Tr. I.	Do.	9 5 30	9 7 0	P.	
—	—	Bisection	9 8 30	—	P.	
—	—	Internal contact.	9 12 0	—	P.	
—	I. Tr. E.	Do.	11 12 0	—	P.	
—	—	Bisection	11 16 0	—	P.	
—	—	External contact.	11 19 0	11 18 0	P.	Invisible after $11^h\ 34^m$ through blurring of the image.
May 22	I. Oc. D.	First contact.	9 51 0	—	P.	
—	—	Disappeared.	9 53 30	9 52 0	P.	
May 23	I. Tr. E.	External contact.	9 16 30	9 16 0	P.	
May 29	II. Oc. D.	First contact.	11 0 30	—	P.	
—	—	Disappeared.	11 4 30	11 2 0	P.	
—	I. Oc. D.	First contact.	11 36 0	—	P.	
—	—	Disappeared.	11 40 0	11 36 0	P.	
May 30	I. Tr. E.	Internal contact.	10 56 0	—	P.	
—	—	Bisection	11 0 0	—	P.	
—	—	Just clear	11 3 0	11 3 0	P.	
May 31	III. Ec. R.	Just glimpsed.	10 0 0	10 2 55	P.	
—	III. Ec. R.	Glimpsed	10 0 45	—	B.	
—	—	Bright	10 5 55	—	B.	

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
June 2	II. Ec. R.	First glimpse.	4 7 44	4 10 0	M.	
—	—	Fully bright.	4 9 54	—	M.	
June 7	II. Tr. E.	Internal contact.	10 12 0	—	P.	
—	—	Just clear	10 19 30	10 12 0	P.	
—	III. Oc. R.	First seen	10 25 0	10 27 0	P.	
—	—	Just clear	10 34 0	—	P.	
—	I. Ec. R.	Just seen	10 55 0	10 55 14	P.	
—	II. Sh.	On disk	—	—	P.	Dark grey, not black.
June 8	I. Tr. I.	First contact.	5 3 36	5 6 0	M.	
—	—	Last contact.	5 7 36			
—	—	On disk	5 9 21	—	M.	Fading.
—	—	Do.	5 17 36	—	M.	Elongated.
—	—	Do.	5 20 21	—	M.	No longer visible.
June 8	I. Sh. I.	First contact.	6 0 51	6 2 0	M.	
—	—	Last contact.	6 4 6			
June 9	I. Oc. D.	First contact.	2 17 29	2 18 0	M.	
—	—	Gone	2 19 24			
—	II. Oc. D.	First contact.	2 30 44	2 35 0	M.	
—	—	Gone	2 35 44			
—	I. Ec. R.	First glimpse.	5 23 9	5 23 49	M.	
—	—	Fully bright.	5 25 14	—	M.	
June 14	I. Oc. D.	First contact.	9 37 0	—	P.	
—	—	Disappeared.	9 42 0	9 39 0	P.	
—	II. Tr. I.	External contact.	10 19 0	10 15 0	P.	
—	—	Bisection	10 22 30	—	P.	
—	—	Internal contact.	10 27 0	—	P.	
June 15	I. Tr. E.	Do.	9 2 0	—	P.	
—	—	Bisection	9 5 0	—	P.	
—	—	External contact.	9 8 0	9 7 0	P.	
—	I. Sh. E.	Internal contact.	10 0 0	—	P.	Shadow very black and sharply defined.
—	—	Just gone	10 7 0	10 8 0	P.	
June 16	I. Oc. D.	First contact.	4 5 3	4 6 0	M.	
—	—	Gone	4 8 53			
—	II. Oc. D.	First contact.	4 55 48	5 0 0	M.	Optical flattening of limb just before first contact.
—	—	Gone	5 1 28		M.	
June 17	I. Tr. I.	First contact.	1 19 39	1 22 0	M.	
—	—	Last contact.	1 23 26			
—	I. Sh. I.	First contact.	2 24 59	2 25 0	M.	

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
June 18	II. Sh. Tr.	On Central Meridian.	2 39 24	—	M.	
—	III. Tr. I.	Just inside disk.	2 18 24	—	M.	Very luminous.
—	III. Tr. E.	After first contact.	3 39 24	3 45 0	M.	
—	—	Last contact.	3 52 24			
—	III. after Tr.	On sky	4 25 0	—	M.	Very faint; fainter than II. or I.
—	—	Do.	5 1 0	—	M.	Now decidedly brighter than II.
June 21	I. Oc. D.	Dis appeared.	11 30 0	11 28 0	P.	
June 23	I. Oc. D.	First contact.	5 54 37	5 56 0	M.	
—	—	Gone	6 1 6			
June 25	II. Tr. I.	First contact.	1 54 13	1 51 0	M.	
—	—	Last contact.	1 59 13			
—	II. Tr. E.	First contact.	4 11 3	4 11 0	M.	
—	—	Last contact.	4 16 28			
—	II. Sh. I.	Do.	4 15 53	4 11 0	M.	
—	—	On Central Meridian.	5 9 48	—	M.	
—	III. Tr. I.	First contact.	5 18 53	5 32 0	M.	
—	—	Last contact.	5 38 43			
June 27	II. Ec. R.	First glimpse.	1 18 44	1 21 19	M.	
—	—	Fully bright.	1 22 24	—	M.	
June 29	III. Ec. R.	First glimpse.	1 55 21	1 56 39	M.	
July 2	I. Oc. D.	First contact.	2 13 53	2 14 0	M.	
—	—	Gone	2 17 23			
—	II. Tr. I.	First contact.	4 20 43	4 18 0	M.	
—	—	Last contact.	4 24 3			
—	I. Ec. R.	First glimpse.	5 34 52	5 36 0	M.	
—	—	Fully bright.	5 37 43	—	M.	
July 3	I. Tr. E.	First contact.	1 40 26	1 44 0	M.	
—	—	Last contact.	1 44 1			
—	I. Sh.	On C.M.	1 40 46	—	M.	
July 4	II. Oc. R.	Half off	1 31 30	1 33 0	M.	Not quite bisected.
—	—	Clear	1 36 30		M.	
—	II. Ec. D.	Fading	1 37 50	—	M.	
—	—	Gone	1 43 30	1 43 22	M.	
—	II. Ec. R.	First glimpse.	3 57 30	3 58 41	M.	
—	—	Fully bright.	4 1 0	—	M.	
July 6	III. Oc. R.	Clear	1 16 43	1 14 0	M.	
—	III. Ec. D.	Fading	4 18 28	—	M.	
—	—	Still circular.	4 19 58	—	M.	

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
July 6	III. Oc. D.	Gone	4 33 54	4 27 33	M.	
—	III. Ec. R.	First glimpse.	5 51 18	5 55 4	M.	
—	—	Fully bright.	—	—	M.	Not noted. Clouds.
July 8	I. Tr. E.	First contact.	9 7 53	—	B.	
—	—	Bisected	9 9 33	—	B.	Unsteady.
—	—	Last contact.	9 11 26	—	B.	
July 9	I. Oc. D.	First contact.	4 1 44	4 6 0	M.	
—	—	Gone	—		M.	Not noted. Clouds.
July 10	II. Tr. I.	First contact.	1 23 42	1 24 0	M.	
—	—	Last contact.	1 26 59			
July 11	II. Oc. D.	First contact.	1 40 1	1 44 0	M.	
—	—	Gone	1 46 16			
July 13	III. Ec. R.	Glimpsed	9 53 50	—	B.	
—	—	Bright	10 0 19	—	B.	
July 16	II. Tr. I.	External contact.	9 18 8	—	B.	Fairly steady.
—	—	Bisected	9 19 19	—	B.	Twilight.
—	—	Internal contact.	9 21 3	—	B.	
—	I. Ec. R.	Glimpsed	9 25 26	—	B.	
—	—	Bright	9 27 3	—	B.	
July 18	I. Ec. R.	First glimpse.	3 53 44	3 54 3	M.	
—	—	Fully bright.	3 56 24	—	M.	
—	II. Oc. D.	First contact.	4 16 14	4 19 0	M.	Disappearance.
—	—	Gone	4 20 14	—	M.	Perfectly regular.
—	II. Ec. R.	Glimpsed	9 11 49	—	B.	
—	—	Bright	9 14 3	—	B.	
July 25	II. Oc. R.	Glimpsed	9 17 23	—	B.	
—	—	External contact.	9 20 35	—	B.	
Aug. 1	I. Oc. D.	First contact.	4 16 39	4 18 0	M.	
—	—	Gone	4 20 14			
Aug. 2	I. Tr. I.	First contact.	1 35 19	1 37 0	M.	
—	—	Last contact.	1 38 14			
—	On disk	Elongation E.W. suspected.	1 45 0	—	M.	
—	—	Elongation certain.	2 4 0	—	M.	
—	—	Still bright.	2 14 0	—	M.	
—	I. Tr. E.	First contact.	3 48 54	3 50 0	M.	
—	—	Last contact.	3 51 59			
—	I. Sh.	On C.M.	3 47 39	—	M.	No penumbra. Circular and black.
—	IV. on sky	Near conjunction.	1 35 0	—	M.	Very faint.

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Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
Aug. 3	I. Ec. R.	First glimpse.	2 11 44	2 12 14	M.	
—	—	Elongated N.S.	2 12 52	—	M.	
—	—	Fully bright.	2 14 24	—	M.	
—	II. Tr. I.	Well on	4 0 0	—	M.	Very luminous.
Aug. 5	II. Ec. D.	Already faint.	1 29 48	—	M.	
—	—	Gone	1 31 53	1 30 17	M.	
Aug. 10	IV. near	Conjunction	1 35 0 to 2 20 0	—	M.	Very faint, and with a strong blue tinge.
Aug. 11	III. Ec. R.	First glimpse.	1 47 52	1 49 44	M.	
—	—	Fully bright.	2 4 21	—	M.	
Aug. 12	II. Oc. D.	First contact.	1 31 49	1 34 0	M.	
—	—	Gone	1 36 29			
Aug. 27	IV. past	Conjunction	1 5 0 to 2 5 0	—	M.	Faint and blue.
Aug. 28	II. Tr. I.	First contact.	1 10 52	1 10 0	M.	
—	—	On	1 16 47			
Sept. 2	I. Oc. D.	First contact.	—	1 7 0	M.	Missed.
—	—	Gone	1 8 45		M.	
Sept. 3	I. Tr. E.	First contact.	—	0 41 0	M.	Missed.
—	—	Last contact.	0 44 13		M.	
—	I. Sh.	On disk	0 55 0	—	M.	Some distance past C.M., sharp and black.
Sept. 12	III. Tr. I.	First contact.	1 52 59	2 4 0	M.	
Sept. 13	II. Oc. D.	Do.	1 51 17	1 54 0	M.	
—	—	Gone	1 56 12			
Sept. 22	II. Tr.	On disk	1 8 8	—	M.	
—	II. Tr. E.	First contact.	—	1 16 0	M.	Missed in a wisp of cloud.
—	—	Clear	1 18 53		M.	Doubtful, definition tremulous.

PART 5.

The Director requested several of the Members of the Section to note the colours and colour changes during the apparition, and some of the notes furnished by the observers are as follows :—

Mr. Townshend, 1899, *April* 30, $11^h\ 10^m$ λ 240°.—Both great belts brown smoke colour; equatorial zone pale pink. Both poles bluish.

May 3, $9^h\ 20^m$ λ 265°.—S. equatorial belt dark mahogany colour, with a bright rift throughout; N. equatorial belt narrow and greenish yellow tint. Equatorial zone ruddy, especially the

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southern section, and gradually fading away into the N. belt, showing no dividing line. Fine equatorial belt grey. S. tropical belt divided from end to end and grey. S. temparate belt same as S. tropical belt. Both poles grey.

May 6, $10^h\ 45^m$ λ 47°.—S. equatorial belt sepia. Following shoulder of bay heaped up to a peak, like a mountain peak, and high. N. equatorial belt pale green and flocculent. Outline of Great Red Spot glimpsed, with greyish centre. Equatorial zone salmon pink, and to the N. melting into the greenish N. belt.

May 26, $11^h\ 5^m$ λ 186°.—Both great belts drab, southern the heaviest. Equatorial zone yellowish. Rifts in belts partake of the general tone of colour, but luminously so.

May 28, 11^h λ 123°.—S. equatorial belt dull olive green; N. equatorial belt dull pale sage green, with horizontal wavy markinge. Equatorial zone pink in centre only, fading into colourless limbs. N. pole heavy grey. An hour previously the equatorial zone was yellow.

June 4, $9^h\ 20^m$ λ 35°.—S. equatorial belt dark slate blue. N. equatorial belt same colour, but less pronounced. Equatorial zone ruddy. Fine equatorial belt seen all the way across the disk, pale grey. At $9^h\ 47^m$ the equatorial zone suddenly changed to a yellow tint, and at $10^h\ 10^m$ it as suddenly changed to a pink tint, and both belts to a mahogany colour. (Mr. Townshend notes that these changes were corroborated by a friend who was with him.)

June 5, 11^h λ 246°.—N. and S. equatorial belts smoky green colour, fading away towards limbs. Equatorial zone pale yellow; fine equatorial belt seen centrally only.

June 6, $9^h\ 25^m$ λ 339°.—S. and N. equatorial belts dull grey; equatorial zone faintly ruddy orange, fading away towards limbs.

June 15, $10^h\ 15^m$ λ 281°.—S. equatorial belt dull pale green, with a luminous pale greenish rift from end to end, and a loop formation centrally of the same colour. N. equatorial belt pale green, with a luminous greenish narrow rift from end to end. Equatorial zone pale yellow. N. pole faintly green.

The pink or ruddy appearance of the equatorial zone remains singularly marked in the region of the Great Red Spot, while the opposite side of the planet assumes uniformly quiescent colours. Mr. Townsend considers the changing colours of the equatorial zone and belts to be due to incandescent vapours of metals.

The Rev. Theodore E. R. Phillips, 1898, *December* 21.—Both equatorial belts reddish chocolate, but the southern belt decidedly the darker of the two. Equatorial zone yellowish orange.

1899, *January* 16.—Both equatorial belts reddish chocolate, other belts grey.

February 27, *March* 20 *and* 22.—Equatorial belts reddish chocolate. Equatorial zone orange.

March 27.—Both equatorial belts a brown red.

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April 4.—Belts less strongly coloured, but still reddish.

April 15.—Equatorial belts reddish chocolate.

April 18.—S. equatorial belt decidedly red. N. equatorial belt a slight tinge of purple.

April 19.—S. equatorial belt red. N. equatorial belt very grey without a trace of red.

April 22.—S. equatorial belt of a very deep chocolate red. N. equatorial belt greyish blue.

May 6.—Both belts reddish.

May 23.—S. equatorial belt deep purplish red. N. equatorial belt grey with a tinge of green. Other belts grey. Equatorial zone yellowish orange.

June 3.—S. equatorial belt deep purplish red. N. equatorial belt much greyer, but with a tinge of red.

June 4.—S. equatorial belt very deep purplish red. N. equatorial belt greyish, but with a decided tinge of red. Other belts grey.

Mr. Phillips remarks that observers seem to vary much in their estimation of colour, and some are much more capable of appreciating variations in tint than others. He instances that Mr. Stanley Williams speaks of seeing various features "as all red" which to his eye are all distinctly grey.

The Rev. Robert Killip, 1899, *May* 19.—The N. equatorial belt is still decidedly green to my eye, as is the portion of the S. equatorial belt preceding the hollow beneath the great shoulder.

June 9.—I always see the difference between the N. and the S. equatorial belts. The shade of the former is dirtier, if I may so say, still the greenish nature of it is there.

Mr. Killip adds,—The colour of the N. equatorial belt—though not very marked in the earlier months—was decidedly and always green to my eye later on. The equatorial zone was never without a tinge of orange; while the S. equatorial belt from first to last was of a chocolate hue.

Mr. Ernest Atkins.—S. polar region. Usually of a browny red colour and rather dense.

S. temperate zone. Noted on nine nights as white, and on 26 as yellowish.

S. tropical band corresponded in colour with the S. equatorial belt.

S. tropical zone always brilliantly white.

S. equatorial belt. Almost always duplex, of a marked red tint, which afterwards changed to a golden brown tone. Always darker and denser than the N. equatorial belt.

Great Red Spot. The bay usually perfectly white, the spot itself either a very faint grey or very slightly warm in tone, especially on May 23.

Equatorial zone a most beautiful yellow colour.

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Equatorial band seen on a few nights, but generally faint.

N. equatorial belt. On the whole about equal in width to the S. equatorial belt, fainter, but always of the same colour

N. tropical zone. Generally white, but occasionally yellowish,

N. temperate band. Seen on several nights. Usually it partook of the tint of the N. polar region.

N. polar region. On some nights its blue tint was very striking, but it was not always blue. On May 29 and June 16 it was noted as being distinctly brownish red. Very often more grey than blue.

The changes of colour deserve careful and systematic observation.

ARTHUR COTTAM,
Director of the Section.

July 13, 1900.
Watford, Herts.

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OBSERVATIONS OF JUPITER, 1899.

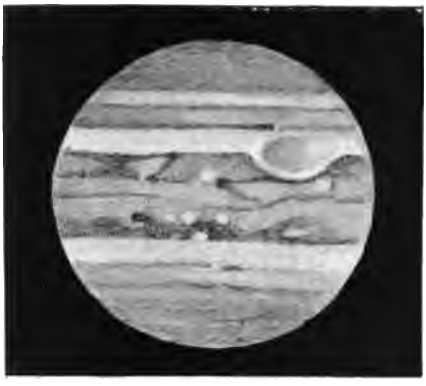

Fig. 1. P. B. Molesworth, 12½ in. Spec.
1899, June 7, 5 h. 57 m. Long. 5°.

Fig. 2. T. E. R. Phillips, 9 in. Spec.
1899, April 19, 11 h. 50 m. Long. 50.1°.

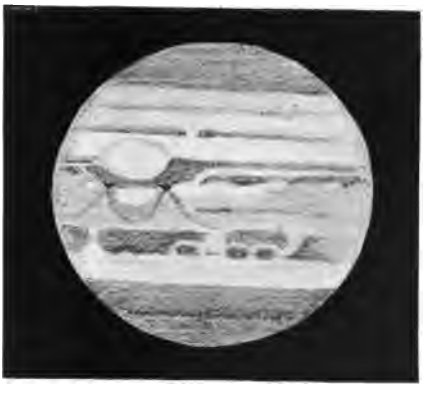

Fig. 3. Scriven Bolton, 4⅛ in. O.G.
1899, June 16, 9 h. 45 m. Long. 54°.

Fig. 4. W. Anderson, 5 in. O.G.
1899, May 9, 9 h. 20 m. Long. 87°.

Fig. 5. E. Attkins, 6½ in. Spec.
1899, April 17, 13 h. 2 m. Long. 153°.

Fig. 6. W. J. Hall, 4⅞ in. Spec.
1899, May 31, 9 h. 30 m. Long. 161°.

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OBSERVATIONS OF JUPITER, 1899.

Fig. 7. W. R. Waugh, 4½ in. O.G.
1899, June 16, 10 h. Long. 220°.

Fig. 8. T. E. R. Phillips, 9 in. Spec.
1899, March 22, 14 h. 5 m. Long. 238°.

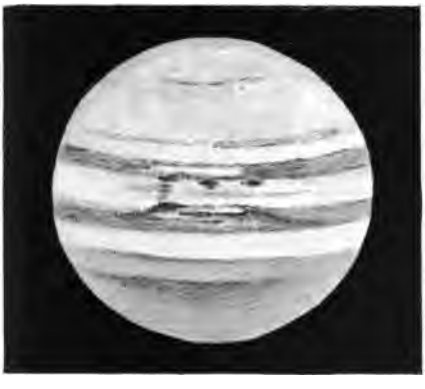

Fig. 9. H. J. Townshend, 10 in. Spec.
1899, June 5, 11 h. Long. 246°.

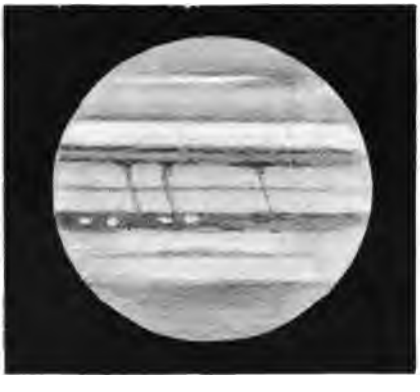

Fig. 10. Robert Killip, 5 in. O.G.
1899, June 3, 9 h. 45 m. Long. 260°.

Fig. 11. J. H. Bridger, 4 in. O.G.
1899, May 27, 10 h. 5 m. Long. 300.5°.

Fig. 12. Charles F. Smith, 5¼ in. Spec.
1899, June 13, 10 h. 25 m. Long. 348°.

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Memoirs

OF THE

British Astronomical Association.

EDITED BY

E. WALTER MAUNDER, F.R.A.S.

AND

F. W. LEVANDER, F.R.A.S.

REPORTS

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SECTION FOR THE OBSERVATION OF METEORS.

DIRECTOR—W. F. DENNING, F.R.A.S.

REPORT OF THE SECTION, 1899.

Introductory.

This year's report is drawn up on similar lines to the reports of preceding years. Several of the periodical showers, such as Quadrantids, Lyrids, Orionids, and Geminids were very inadequately observed in 1899 owing to cloudy weather and moonlight. Of the Leonids, much was expected and little realised. The shower came, it is true, but only in the strength of an ordinary year, though the earth should have passed through that rich region of the orbit just following the parent comet, for the latter must have returned to perihelion in the spring. Next November promises to display the missing shower, unless, indeed, the dense part of the stream has been perturbed and is enabled to evade contact with the earth, which seems quite possible. The August Perseids were watched under the best observational conditions, though the return was not of exceptional strength, and the slow-moving meteors of Biela's comet formed a marked shower on November 23 and 24, though the phenomenon could not rank with the displays of 1872 and 1885. A large number of fireballs have been observed during the year, but the observations of some of these were not sufficiently exact for their real paths to be computed. Simultaneous watches have been arranged at various periods during the year, and a number of meteors have been recorded by two or more observers. The particulars of these are given in a tabulated form. They are regarded as of considerable interest, not only as affording useful evidence as to the heights at which these bodies are consumed, but as giving the radiants both of active and well-known systems, and of very weak showers which have escaped other means of determination. Interim reports have been published as follows:—August Meteors, "Journal," Vol. IX., p. 429; November Meteors, Vol. X., p. 56; and to these the student is referred for details supplementary to those appearing in the present report. The Section numbers about 20 Members. Messrs. Astbury, Besley, Bridger, and King have sent in monthly summaries of their observations, which are of considerable fullness and value. The Director has also had the advantage of receiving a large number of observations from Prof. A. S. Herschel, at Slough, and of comparing notes with him. Acknowledgment should also be made to Lieut.-Col.

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Tupman, who has kindly computed the real paths of six bright Perseids seen in August last.

Bristol, March 18, 1900.

W. F. DENNING, Director.

Record of Meteoric Observations.

QUADRANTIDS.

Moonlight and stormy weather almost obliterated this display. Mr. J. H. Bridger, at Farnborough, watched on January 1 from 7.30 to 8.30 and noted two Quadrantids and five other shooting stars. Mr. T. W. Backhouse reports that the sky was unfavourable. On January 1, in 37 minutes he noted five Quadrantids. The Rev. T. E. R. Phillips, Yeovil, observed four meteors, including three pretty bright Quadrantids, in a quarter of an hour on evening of January 2. Mr. A. King, Leicester, watching at intervals before 9.30, saw five meteors on January 1, but the sky was overcast on January 2. The Rev. S. J. Johnson, of Bridport, noted six meteors on January 2 following same direction (Quadrantids) between 6^h 50^m and 7^h 20^m, but in the next half an hour not one was seen. At Bristol, the night of January 2 was stormy, and only two Quadrantids were seen through clear openings at 6^h 14^m and 7^h 40^m.

LYRIDS.

Mr. Bridger, on April 11, saw six meteors between 9^h and 11^h 30^m; on April 12 not one was seen in $1\frac{1}{2}$ hours between 9^h and 11^h. Later nights were unfavourable, and very few meteors observed. Prof. Herschel watched for the shower on the nights of April 16, 17, and 19, but saw very little indication of it, and there appeared to be very few meteors from the minor radiants of this epoch. There was, however, a tolerably active shower in Canes Venatici. Mr. Besley reports that April 19 was the only date which offered a prospect for making observations, but that he saw no meteors in about $1\frac{1}{2}$ hours. Mr. Astbury writes that on April 18 the sky was fairly clear, April 19 bright moonlight, April 20 raining, April 21 cleared up after a day's rain, and a few meteors were recorded, but there was no sign of the Lyrid shower.

MAY AQUARIDS.

During the period May 3–7 the sky was beautifully clear, and Prof. Herschel registered 85 meteors in 16 hours of observation. Several of the long-pathed Aquarids were seen just before daylight. Prof. Herschel has combined these observations with a series which he obtained on similar dates in 1894, and deduced a considerable number of radiants (*see* list) with unusual precision. Mr. E. R. Blakeley, of Dewsbury, watching on May 3–7, counted 67 meteors in about $9\frac{1}{2}$ hours, but saw no Aquarids. He found meteors exceptionally numerous on May 7 between 11^h and 11^h 30^m.

JULY METEORS.

Between July 28 and August 1 Mr. King registered 76 meteors, but these included only three Aquarids. Mr. Astbury, Mr. Bridger, and others obtained a large number of observations

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at this period, but the Aquarids were not strongly represented. At Bristol, eight members of this shower were charted between July 30 and August 13. A few early Perseids were also seen by the various observers during the last week in July.

AUGUST PERSEIDS.

The weather proved excellent on and after August 9, and the moon being absent, this well-known stream was witnessed to the best advantage. The following are some of the summarised results :—

Date.	Interval of Observation.	Duration.	All Meteors.	Perseids.	Radiant.	Observer.
	h m h m	h m			α° δ°	
Aug. 1 -	9 0—11 10	2 10	18	5	30 +54½	J. H. Bridger, Farnborough.
„ 2 -	10 18—11 29	1 11	11	2	—	
„ 4 -	9 40—11 7	1 27	8	1	—	
„ 8 -	9 52—10 48	0 56	5	1	—	
„ 9 -	10 45—12 30	1 45	29	15	41 +55½	
„ 10 -	9 43—11 47	2 4	46	21	43 +56	
„ 11 -	9 15—12 0	2 45	59	29	45 +57	
„ 12 -	10 6—11 55	1 49	34	12	46 +56½	
„ 14 -	9 20—11 51	2 31	19	5	52 +58½	
„ 10 -	10 35—15 0	4 25	86	54	45½+58½	W. E. Besley, Clapham, London, S.W.
„ 11 -	10 5—11 13	1 8	15	8	45 +57	
„ 12 -	10 25—12 15	1 50	30	15	48 +58	
„ 14 -	10 50—13 0	2 10	24	5	50 +58	
„ 6 -	10 0—12 0	1 45	18	6	40 +55	W. F. Denning, Bristol.
„ 9 -	10 0—13 0	2 0	38	26	44 +57	
„ 10 -	10 0—13 30	3 0	91	72	44 +57	
„ 11 -	10 0—13 0	3 0	90	69	46 +57	
„ 12 -	10 0—13 0	3 0	62	43	48 +57	
„ 13 -	10 0—12 30	2 0	23	10	49 +58	
„ 14 -	10 0—12 30	2 30	29	12	50 +56	
„ 16 -	10 30—14 30	3 30	43	7	53 +57	
„ 10 -	9 6—14 36	5 30	104	84	45 +56	E. M. Antoniadi, Juvisy, France.
„ 11 -	9 6—14 36	5 30	138	116	46½+56	
„ 12 -	9 6— 9 56	0 30	7	6	46 +57	
„ 13 -	9 36—11 36	2 0	22	15	48 +55	
„ 8 -	9 50—11 50	2 0	21	—	—	A. King, Leicester.
„ 9 -	9 50—13 5	3 15	55	7	44½+57	
„ 10 -	10 10—14 10	4 0	67	29	45 +57	
„ 11 -	10 25—14 0	3 35	84	17	46 +57	
„ 12 -	11 15—13 30	2 15	35	7	48 +58	
„ 13 -	10 30—12 30	2 0	25	5	49 +57	
„ 14 -	9 45—12 0	2 15	19	8	49 +58	

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Mr. T. W. Backhouse, at Sunderland, was struck with the large proportion of bright meteors. This could not be accounted for by the misty weather. Of 84 meteors seen at this epoch he recorded 1 = ♀, 3 = ♃, 8 = Sirius, 14 = mag. 0, and 7 = mag. 1. On August 10, watching between 10^h and 13^h 30^m for a discounted period of 1^h 53^m he saw 36 meteors (31 Perseids). On August 11, 9^h 58^m to 13^h 59^m (period 2^h 6^m) he noted a precisely similar number, so the maximum was indicated for August 10.

Mr. T. H. Astbury, at Wallingford, usually watched between 10^h and 11^h. In this hour he saw the following numbers of meteors, August 10, 34, August 11, 18, August 12, 30, August 13, 18, and August 14, 17. Of 82 meteors which he actually recorded between August 8–14 the great majority were Perseids, and the radiant appeared very diffuse. On August 10 several Cygnids were seen, and on later nights a few paths indicated a radiant near γ Andromedæ.

Prof. A. S. Herschel counted 104 meteors on August 10 11^h 10^m to 14^h 35^m and mapped 65 of these. The sky was clear and dark, and the horary rate = 30 or 42, if time is allowed for writing notes, &c. On August 11, 11^h to 12^h he saw 22 meteors, then clouds intervened. Between $12\frac{1}{2}^h$ and $13\frac{1}{2}^h$ there were 15 meteors, so that the strength of the display was evidently declining.

Mr. H. Corder, at Chelmsford, was watching for some hours on August 10, and counted 116 meteors.

Mr. Ivor F. H. Carr Gregg observed the shower from the Malvern Hills. It seemed about equally rich on August 10 and 11, and both nights were cloudless. Two observers obtained the following numbers:—

	h m	h m	
August 10 -	12 15	to 15 15.	127 meteors
„ 11 -	11 0	to 16 0.	210 meteors

Magnificent meteors as bright as or brighter than ♀ were seen on August 10, 13^h 55^m, August 11, 13^h 44^m, and 13^h 57^m. These objects lit up the sky and left streaks enduring for about half a minute. The time of greatest frequency was August 11, 13^h to 13^h 15^m when 23 were seen, and the rate was 92 per hour.

Mr. W. H. Milligan, of Belfast, has published the results of his observations as follows: On August 4 he saw some meteors, including a stationary one from the radiant in the position* near η Peresi, which is really six degrees W. of its real place on August 4. On August 8 he counted 10 Perseids with diffuse radiation. On August 10 and 11 the meteors fell pretty constantly, but they did not seem so strong as in previous years. Maximum was thought to occur on August 11, 11^h to 11^h 30^m local time, hourly number about 60. Display fell off on August 12, and on August 14 everything was much as usual. The sub-radiants were at 10° + 38° and 70° + 55°.

The Rev. W. R. Waugh watched for about two hours on July 31, August 4, 9, and five following nights, seeing about 15

* Mr. Milligan has in several years observed the Perseid radiant at about 44° + 57° August 3–6. Its correct position on August 4–5 is $38\frac{1}{2}$° + $55\frac{3}{4}$°. the Director is entirely at a loss to explain the cause of this discordance.

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Perseids and some other meteors, including several from a radiant near α Persei.

Mr. G. Carslake Thompson, of Cardiff, made a series of observations of the Perseids on August 10, 11, and 12. The number of meteors counted on the three nights was 58, 174, and 27 respectively. A full account of his observations appears in the Cambrian "Natural Observer."

Mr. C. L. Brook, of Meltham, near Huddersfield, saw 20 meteors on August 10, 9^h 50^m to 11^h. On August 11, 14 were seen in the hour from 9^h 55^m to 10^h 55^m.

Briefly reviewing the results, it may be said that the shower was not a brilliant one, certainly not so rich as on August 11, 1898, but it was seen to great advantage in the clear moonless skies which prevailed just at the important time. The easterly motion of the radiant was amply corroborated by a comparison of the radiants determined on the several nights of observation. Some of the most brilliant Perseids were recorded by several observers, and their real paths are included in the table. In 1899 the maximum was variously estimated as occurring on August 10 and 11, and there seems to have been very little difference in the relative strength of the shower on the two nights. Remembering that the maximum occurred in 1898 on August 11, and that 1900 is not a leap year, we must expect the Perseids to be more numerous on August 11 than on August 10 in future years.

Of the minor showers a considerable number manifested themselves. Prof. Herschel and Mr. King saw a fair proportion of Camelopardids, while the latter and Mr. Besley detected active showers in Cassiopeia. At Bristol the most prominent shower was at 277° + 70°, and there were also definite radiants near β Piscuim, κ Cephei, ϵ Draconis, &c. The Director finds many of the same streams exhibited every year, in fact they appear to be as certain in their recurrences as the Perseid shower itself. 1893, like 1899, was a very auspicious one as regards weather conditions for the Perseids, and some of the secondary showers recognised on the former occasion at Bristol compare with the results in 1899 as under :—

1893.		1899.	
No. of Meteors.	Radiant.	Radiant.	No. of Meteors.
8	19° + 29°	16° + 31°	4
5	41 + 23	40 + 21	5
11	48 + 44	47 + 44	6
6	310 + 77	315 + 77	10
6	347 ± 0	345 ± 0	9

But in 1893 there were notable showers of Cygnids (292° + 53°, 28 meteors), and η Cepheids (311° + 62°, 17 meteors) apparently wanting in 1899, and the shower of ϕ Draconids, seen in the latter year, was absent in 1893. No doubt there are variations in

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strength from year to year, and the feebleness of certain displays often enables them to evade detection.

ORIONIDS.

The moon was full, and very few of these meteors were noticed. Some interesting observations of meteors were, however, secured by Prof. Herschel, and Messrs. Astbury, Bridger, and King during the first half of October. These sufficiently show that the Orionid shower commenced at an earlier date than usual, and yielded some brilliant meteors at a time before it is customary to expect them. On October 10 a Venus-like Orionid, was recorded by Mr. Bridger, and on the following night Prof. Herschel detected the on-coming of the shower. In half an hour of pretty clear sky he mapped two Orionids indicating the radiant at $92°+17°$. On October 16 another brilliant member of the same system was seen by Mr. Davies at Chichester, and these various objects are included in the list of bright meteors. During October, Mr. Bridger watched for nearly 15 hours (13 nights), and counted 83 meteors, but there were only two Orionids amongst them. Near the time of the maximum, however, (October 18–22), few observations were obtained. Moonlight, cloudy or misty weather, often practically obliterate a shower which, under the best possible circumstances, would offer a fairly conspicuous display. In judging of the character of an event of this nature we must always carefully consider the conditions which greatly influence its visible aspect. Though very little was noticed of the Orionids of 1899, they might have formed an average display had it been possible to view them without hindrances.

LEONIDS.

Another failure! Yet it was thought that the display of 1899 would more than compensate for the weak showers of 1897 and 1898. The failure is much deplored in view of the universal effort to witness the phenomenon and secure useful observations. No meteoric event ever before aroused such an intense and widespread interest, or so grievously disappointed anticipation. The scientific journals and newspapers all contained references to the subject, and the occurrence was predicted in such confident terms to take place that the public became enthusiastic, and looked forward to its appearance as a certainty. Many people regard the prescience of the astronomer as something marvellous, he can foretell the moment of an eclipse that will occur generations hence, and no thought of questioning either his accuracy or veracity ever enters their heads. Thus everyone expected that when they looked up to the sky on the night of November 14–15 they would see it full of meteors. But the fiery storm did not appear. The firmament, with its glittering stars and silver moon, was just as still as on an ordinary mid-November night. Only now and then, indeed, a shooting star rapidly streaked along the sky to prove that the Leonids were present in a weak and scattered shower in place of the dense and brilliant display that had been awaited. The finest celestial sight of a generation had failed to come at its appointed time, and the disappointment was all the keener in some quarters from the impression which prevailed that another chance of witnessing it would not occur until 1933.

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A very large number of observations have been received by the Director. They show that elaborate preparations had been made to suitably record the event. But from stations both at home and abroad—from America, India, Australia, Norway, Russia, China, &c.—the story of meagre results is much the same. A few of the Leonid meteors, with their rapid flights and luminous streaks, were seen shooting from the familiar configuration of stars forming "the sickle," but there was no sign of a grand display anywhere. The photographic method, of which so much was expected, furnished little but blanks owing to the paucity of bright meteors, and possibly the prevalence of moonlight may have exercised a bad effect.

Some of the results have been already tabulated in the interim Report ("Journal," Vol. X., p. 56), and selections from others are given here. The summary is by no means complete, but it is thought that no important end would be gained by quoting a large mass of results of negative character. To the numerous Members of the Association and others situated in various parts of the world who, though not belonging to the Meteoric Section, have supplied descriptions; the Director begs to tender his sincere thanks.

Mr. H. G. Tomkins writes from Allahabad, India, enclosing a valuable digest of observations, both in 1898 and 1899. He says that a party of 11 men volunteered for the work, and that they were carefully instructed as to details. The results obtained were as under:—

Date.	Hours of Observation.	Leonids.	Other Meteors.	Remarks.
1899.	h h			
Nov. 7	14 to 16	11	37	Leonids small; sky clear.
„ 8	14 „ 16	12	20	One large, others small; sky misty.
„ 9	14 „ 16	15	1	Seven bright; sky clear.
„ 10	14 „ 16	6	25	Small; sky clear
„ 11	14 „ 16	15	32	Three bright; sky clear.
„ 12	14 „ 16	15	48	One bright; sky misty.
„ 13	10½ „ 13	3	5	Sky clear.
„ „	13 „ 15⅓	17	28	„
„ „	15⅓ „ 17½	30	5	„
„ 14	10½ „ 13	5	Not recorded.	Sky misty.
„ „	13 „ 15⅓	17	4	Partly cloudy.
„ „	15⅓ „ 17½	58	26	„
„ 15	10½ „ 13	1	4	Sky clear.
„ „	13 „ 15⅓	13	1	„
„ „	15½ „ 17¼	38	4	„
„ 16	14 „ 16	1	Not recorded.	Cloudy.
„ 17	14 „ 16	8	„	„
„ 18	14 „ 16	1	2	Sky clear.
„ 19	14 „ 16	2	4	„
„ 20	14 „ 16	0	2	„
„ 21	14 „ 16	2	4	„

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Mr. Tomkins notes that the meteors generally were very small. This may have been partly due to moonlight, but even after the moon had set very few of those seen were brighter than 3rd mag. In point of numbers the shower was distinctly inferior to that of last year; indeed so poor was it that he did not think it worth while to expose his cameras, although he had six in readiness.

Mr. Tomkins has drawn up the following table showing a comparison of the results in 1898 and 1899. In 1898 the watch was kept in Madras, in 1899 at Bombay.

Date.	Hours.	1898.		1899.	
		Leonids.	Sky.	Leonids.	Sky.
	h h				
Nov. 7 -	14 to 16	3	Cloudy -	11	Clear.
„ 8 -	„	0	„ -	12	Misty.
„ 9 -	„	6	Not stated -	15	Clear.
„ 10 -	„	21	„ -	6	„
„ 11 -	„	28	„ -	15	„
„ 12 -	„	28	„ -	15	Misty.
„ 13 -	10⅓ to 13	23	Cloudy -	3	Clear.
„ 13 -	13 to 15⅓	0	„ -	17	„
„ 13 -	15⅓ to 17⅓	33	Clear -	30	„
„ 14 -	10⅓ to 13	0	Cloudy -	5	Misty.
„ 14 -	13 to 15½	101	Clear after 14th.	17	Partly cloudy.
„ 14 -	15½ to 17½	151	Clear -	58	„
„ 15 -	10⅓ to 13	60	„ -	1	Clear.
„ 15 -	13 to 15½	166	„ - -	13	„
„ 15 -	15½ to 17⅔	216	„ -	38	„
„ 16 -	14 to 16	38	„ - -	1	Cloudy.
„ 17 -	„	18	„ -	8	Clear.
„ 18 -	„	15	„ - -	1	„
„ 19 -	„	17	„ -	2	„
„ 20 -	„	16	„ - -	0	„
„ 21 -	No watch kept.		—	2	„
	Total Leonids	940		270	

In 1899 the maximum was distinctly marked for November 14, $16^h\ 50^m$. The hourly rates on November 14 and 15 were as follows:—

	h h		
November 14 -	15 to 16	- 7	Leonids.
	16 to 17	- 43	„
	17 to 17¼	- 13	„
		63	„
	h h		
November 15 -	15 to 16	- 9	Leonids.
	16 to 17	- 20	„
	17 to 17¼	- 10	„
		39	„

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Mr. Tomkins adds that meteors from other radiants were carefully excluded from the Leonids. The Taurids and Orionids were pretty active, most of the other meteors coming from these radiants. The observations were undertaken to determine the number of meteors and the time of their maximum abundance. It was intended to utilise photography in getting the position of the radiant point, but the poorness of the display prevented this being accomplished. The watches on November 13 to 15 inclusive were kept by three observers; two of them facing opposite directions (E. and W.) kept count while the third called time every five minutes.

The Rev. Ellis G. Roberts sends observations made by members of the staff and undergraduates of Noble College, Masulipatam, South India. The shower seems to have been at its thickest on November 15, $15^h\ 45^m$ to $17^h\ 15^m$, local time. 15 Leonids of about mag. 1 were seen in this half an hour, ending November 15, 17^h. Mr. Ellis sends a list of the more brilliant Leonids, and has been training his native assistants to take observations. He says they are very keen on it, but require a good deal of guidance.

Capt. P. B. Molesworth forwards some interesting notes from Trincomali, Ceylon. He attempted to photograph the swarm in the open sky in the moonless nights before and after the shower. He also made an effort to obtain the place of the radiant photographically by cameras equatorially mounted and pointed to the sickle, "and to obtain visual observations as well."

In endeavouring to photograph the swarm, the instrument used was a 6-in. Marion portrait lens of 36-in. focus, mounted on a $12\frac{1}{2}$-in. Calver equatorial, which was employed as a guiding telescope. Dr. Downing's ephemeris of the group was used, and in the moonless period just preceding the shower-date seven photographs were taken. Cloudy weather prevented any photographs being secured after the shower. No trace of the swarm could be detected on any of the plates. On November 15, after the moon had set, an attempt was made to photograph the radiant, but no meteor trails were detected upon any of the plates after their development. Capt. Molesworth's visual observations were somewhat fragmentary, as he had no assistant, and was much occupied with his instruments. On November 8, $14^h\ 40^m$ to $16^h\ 52^m$, two doubtful Leonids were seen. On November 9, 16^h to $16^h\ 50^m$, several meteors were observed, of which two were almost certainly Leonids. November 10, $14^h\ 20^m$ to $16^h\ 50^m$, another clear night, and two further Leonids appeared. Little was seen on the few subsequent nights. On November 15, $15^h\ 15^m$ to $16^h\ 50^m$, 15 Leonids and six unclassed meteors were noted, but during the first half-hour of the watch there were drifting clouds. In concluding his report, Capt. Molesworth says his observations were, speaking generally, a failure, but the nights of November 13 and 14 were too cloudy to make observations.

At the Astronomical Observatory of Zosè, Shanghai, China, the sky was beautifully clear on the nights of November 14, 15, and 16. About 60 Leonids were seen on the three nights, and they were most numerous on November 14 at about 17^h, local time. Brilliant Leonids were observed on November 14, $14^h\ 7^m$, and November 15, $15^h\ 40^m$. The latter crossed Sirius and went

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25° beyond that star, leaving a long streak, and finally bursting. All the Leonid meteors radiated from within the loop of the "Sickle."

Mr. W. A. Parr, writing from Florence, states that he was unable to detect any of the Leonids, but that Signor Abetti, of the Arcetri Observatory, informed him that on November 14, 16^h to 17^h, local time, 10 bright Leonids were observed. On November 15 the sky was veiled in fog.

The Rev. A. L. Cortie, S.J., reports from Stonyhurst College Observatory that the night following November 14 was overcast. November 15 was fairly fine, and a continual watch of the S. and E. sky was kept from 10^h to 18^h 45^m. Only 22 meteors were seen, and of these 14 were noted during the interval from 14^h 28^m to 15^h 48^m. Ten of the meteors were almost certainly Leonids. They were swift, of a greenish tint, and had long paths. The brightest meteor observed during the night appeared at 16^h 49^m. It outshone Venus, and the beautiful emerald green streak it left behind was visible 12 seconds after the disappearance of the nucleus. Path, $144\frac{1}{2}° + 24\frac{1}{2}°$ to $109\frac{1}{4}° + 28°$. As to the Leonid radiant, six of the meteors radiated from a point near ϵ Leonis, while two others intersected near γ Leonis. Four of the tracks point to a radiant near α Orionis, and five others were sporadic.

Prof. E. E. Barnard, of the Yerkes Observatory, writes that they were prepared with 16 cameras and Mr. Ritchey's 24-in. reflector, to take photographs of the Leonids, but solid clouds prevented their seeing anything of the shower.

Mr. J. Evershed, of Kenley, Surrey, watched on November 14, 13^h 25^m to 14^h, and saw two Leonids. Between 15^h and 16^h, there were four Leonids. On November 15, the weather was generally unfavourable, but from 16^h 30^m to 16^h 50^m, three Leonids were noted through breaks in the clouds. So far as his observations enabled him to judge, he thought there were no more Leonids visible than during an average return of the shower, and certainly less than at an average display of Perseids.

Messrs. Wiblin, Jones, Pereira, and Alderson, undergraduate members of Jesus College, Oxford, watched from the college quadrangle on November 14, 15^h 15^m to 18^h 15^m, and saw about 50 meteors, which, for the most part, radiated from the "Sickle" of Leo, only about half-a-dozen being from other constellations. The majority were in the N. and passed through Ursa Major. The meteors were most frequent and brilliant between 17^h 30^m and 18^h. At 17^h 38^m, a large and very brilliant meteor of a peculiar violet colour passed from near Leo to Auriga, leaving a nebulous train for three minutes.

Mr. A. King, Leicester, saw 10 Leonids on November 15, 13^h 15^m to 17^h 15^m, and found the radiant at $151\frac{1}{2}° + 22°$. The horary number was only 2·5, but many small meteors probably escaped detection in the moonlight.

Mr. J. H. Bridger, of Farnborough, reports that on November 14, stars to the 2nd or 3rd mag. were visible in early part of the night, but that not a single meteor was seen. On November 15, he was on the look out after 11^h, but the clouds never

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broke until 17^h, when there was just enough clear sky to show that no great shower was in progress.

Mr. Ivor F. H. Carr Gregg, of Great Malvern, saw the first Leonid on November 10, at about $12^h\ 40^m$. On November 14, he watched at intervals between 12^h and 18^h, and counted 35 meteors, of which 32 were Leonids.

Mr. T. H. Astbury, of Wallingford, in about 90 minutes of perfectly clear sky on November 14, $16^h\ 3^m$ to $17^h\ 53^m$, saw 37 meteors, including 31 Leonids. The latter generally had a brilliantly white nucleus with a streak of bluish green which appeared to open out slowly, widest at middle of their length, about one second after the nucleus had disappeared. Another point noted was that the streak usually fell short of the point where the head vanished. The average duration for the meteor would be about three-eighths of a second, but several of the streaks lasted quite 10 seconds. The meteors were bright, and mostly 1st or 2nd mag. A fine Taurid or Arietid brighter than 1st mag., was recorded at $17^h\ 8^m$, with a path from $142° - 11°$ to $162° - 16°$. At 17^h, the Zodiacal light was well seen; poorly defined, but extending some degrees further W. than β Virginis.

Prof. A. S. Herschel, of Slough, only mapped five Leonids on the nights from November 12–16, the weather being very unfavourable. He saw 69 non-Leonids between November 6–16, and has published a full description of these observations in "Nature," Vol. 61, p. 225.

Sir W. J. Herschel, of Littlemore, near Oxford, watched the sky on November 14, $13^h\ 15^m$ to $18^h\ 15^m$, and with a small party of assistants counted 62 Leonids and 40 non-Leonids. The former were increasing at the end of the watch, and the maximum was either attained or immiment. At $17^h\ 40^m$, a brilliant meteor traversed a path from $163° + 63°$ to $72° + 66°$, and left a streak for five minutes (*see* "Journal," British Astronomical Association, Vol. X., p. 59, and "Nature," Vol. 61, p. 223).

Mr. T. W. Backhouse, of Sunderland, made observations on November 8, 10, 11, 13, 14, and 15, but only five Leonids were recorded. On November 15, between 10^h and $18^h\ 26^m$, the sky was watched at intervals, amounting to about two hours, but only 10 meteors appeared, and of these four were Leonids. The display was evidently very weak, and moonlight and other hindrances served to obscure it.

The Rev. R. Killip, of St. Anne's-on-Sea, organised a small band of watchers, and the sky cleared on November 15 at 13^h. Between $15^h\ 30^m$ and 18^h, 23 Leonids were seen including very brilliant ones at $16^h\ 43^m$ and $16^h\ 47^m$. The latter was as bright as Venus, and left a greenish blue train for two minutes. Mr. Killip saw the peculiar arc of light described by Mr. Baxendell, at Southport, on the morning of November 16, and quoted in the Interim Report ("Journal," Vol. X., p. 60). The former says it was visible at about $12^h\ 20^m$, and it was from first to last more than slightly curved. Indeed, when first noticed, so archlike was the phenomenon, that for the moment it was thought to be a lunar rainbow. It was certainly an extraordinary spectacle, whatever its cause. Mr. Killip says, "I cannot confirm Mr. B. that its "direction was from S.W. to N.E., for, although we watched it

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" until nearly 14^h, it lay towards the N.W. from the E. It had " a slow movement northwards, and faded away very gradually. " It was, as Mr. B. says, broader at one end (E.) than the other, " and in some respects resembled a comet, only that it was too " arched. There was occasionally the faintest trace of colouring, " viz., a tinge of red, and once, at least, a suspicion of green. " We remarked to each other several times that it could be no " mere cloud effect."

Mr. W. C. Tetley, of Aspley Guise, Beds., counted 29 meteors on November 14, between midnight and dawn, and saw the fireball which appeared at $17^h\ 40^m$. He gives the point of its disappearance as $61\frac{1}{4}° + 24°$, and describes the path of the meteor as making an angle of 75° with the line joining α Tauri and the Pleiades. This object was also seen at four different places in or near Oxford, and also by the Rev. T. E. R. Phillips, at Yeovil. The real path of this brilliant meteor is given in the table.

Mr. G. Holland, of Eccles, in conjunction with 15 other observers, watched the sky on November 15, $13^h\ 10^m$ to $15^h\ 10^m$. There were three photographer's in charge of four cameras, and 11 of the observers were employed in counting the meteors as they appeared in various parts of the sky. The total number enumerated was 59 in the two hours. The photographic results were nil.

Dr. R. J. Ryle, of Brighton, on November 14, $14^h\ 30^m$ to 18^h, saw 28 meteors, of which five or six were about 1st mag. Some of the meteors were white, others decidedly greenish white, others again, yellowish with ruddy tinge. The brightest meteors were distant from the radiant, and whereas those near the radiant were generally greenish white those most distant from it were ruddy. Most of them left streaks, but none lasted more than three seconds. Twenty-four of the 28 meteors seen were directed from the sickle of Leo. The tendency of the meteors seemed to be to occur in couples.

Mr. J. E. Clark, of S. Croydon, watched on November 13, $17^h\ 8^m$ to $17^h\ 50^m$, and saw seven Leonids. On following nights the weather was cloudy, and no meteors seen. The radiant on November 13 appeared to be as nearly as possible half-way between γ and ζ Leonis.

Mr. N. Maclachlan, of Largs, Ayrshire, looked for the shower on November 14, $16^h\ 20^m$ to $17^h\ 20^m$, and sends a list of 16 meteors (12 Leonids) observed. At $16^h\ 50^m$, he recorded a stationary Leonid. It blazed out like a 2nd mag. star between μ and ϵ Leonis, and lasted one second. The Leonids were swift, and several left trails.

Mr. Robert Service, of Dumfries, states that the night of November 14 was overcast over the greater part of Scotland, except for about an hour before sunrise. Only a score or less of meteors were seen. On November 15 the sky at Dumfries cleared at 13^h, and he noticed 20 meteors (15 Leonids) during the night. The sky was not favourable, having that gray appearance through which it is difficult to see the stars.

Mr. A. R. Schutz, of Worthing, Sussex, appears to have had better success than most of the observers. He says " on " November 13 we had some six or seven stragglers. On

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"November 14, between 15^h and 18^h, he saw *not less* than 200, "all Leonids." November 15 was cloudy. Mr. Schutz gives no details as to the number of observers or method of counting, It seems probable that his figures are merely a rough estimation.

Mr. A. C. Allen, of Eccleshall, Staffs, reports that on November 14, $16^h\ 30^m$ to $18^h\ 45^m$, he counted 19 Leonids and 11 other meteors. One magnificent Leonid appeared at $16^h\ 51^m$. It disappeared halfway between η and δ Hydræ, leaving a bright trail first curved downward and then seemed to roll itself up, and then remained a stationary cloud visible for full 3 minutes at $127° + 4°$.

Mr. J. H. Pledge, of London, N.E., watched a partially obscured sky on November 13, 12^h to $15^h\ 33^m$, but counted only nine meteors. On November 14 the sky was overcast. On November 15 fog prevailed, and only four meteors appeared between $12^h\ 57^m$ to $13^h\ 33^m$, soon after which all celestial objects were hidden.

Mr. J. A. Greenwood, observing near Chichester, registered about a dozen Leonids on November 14, 14^h to $15^h\ 13^m$. They were tolerably bright meteors, comparable to Regulus, and with paths radiating from the centre of the "Sickle."

The Director's results were practically nil on the important night of November 14, as the sky was cloudy. Mr. Besley, at London, Rev. T. E. R. Phillips, at Yeovil, Mr. Arthur Mee, Cardiff, Rev. S. J. Johnson, Bridport, Mr. P. M. Ryves, Weybridge, and others, were equally unsuccessful owing to the weather, which quite obliterated the display.

Briefly reviewing the results, it is certain that the first Leonids were seen on November 8, the last probably on November 19. The maximum, such as it was, occurred before daylight on November 15. The shower was less rich than in 1898, and not so strong as an average display of Perseids. The Leonid returns of 1879 and 1888, when the parent comet was not far from aphelion, were probably quite as rich as the shower of 1899, though it recurred only a few months after the comet had passed through perihelion. It appears likely that the stream has been disturbed since its return in 1866–68 by the action of Jupiter and Saturn, but there is sufficient doubt in the matter to encourage observers to look again for the shower next November. There will be moonlight, but our satellite being near her last quarter, it will not afford such a serious hindrance as it did in 1899. When we remember that there were brilliant displays in 1866, 1867, and 1868 we need not despair of seeing the Leonids at their best until after 1901 is past.

THE METEORS OF BIELA'S COMET.

There was a very distinct, though not very brilliant, return of this shower on the nights of November 23 and 24. Little was seen of it in England, however, owing to cloudy skies. Mr. C. E. Willis, of Norwich, reports in "Nature" of December 7, 1899, that on November 24, between 10^h and $11^h\ 25^m$, he saw 52 Andromedids and 10 other meteors.

Prof. Young, of the Princeton Observatory, saw 42 meteors of this shower on November 23, and secured several photographs. The shower was also seen at Charkow, Delhi, Lemberg, Vienna, Pola, Munchen, Boston Mass., Northfield Minn., and other places. At Vienna, on November 23, 6^h to $9^h\ 40^m$, 65 meteors

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were seen, while on November 24, 6^h to 10^h 30^m, 240 were counted. The maximum was at about 8^h (6^h 55^m G.M.T.). Mr. Gregg, at Malvern, watched for the shower on November 23, and saw three of its meteors between 9^h and 9^h 30^m, when the sky unfortunately became cloudy.

DECEMBER GEMINIDS.

A gibbous moon and the prevalence of a very severe frost and snowstorms prevented the successful observation of these meteors. Mr. King reports that he looked out as follows:—

December 1, 10^h to 11^h, six meteors, no Geminids.
8, 9^h 35^m to 11^h 10^m, nine meteors, two Geminids.
13, 17^h 10^m to 18^h 30^m, five meteors, no Geminids.

Mr. T. W. Backhouse watched for short periods on the nights from November 25 to December 14, but very few meteors were seen. Mr. T. H. Astbury says that there was a considerable number of Geminids observed on December 8 and 9, the chief centre of radiation being at about 110° + 25°, and much further S. than he had expected to find it. Mr. Gregg watched the sky on December 10, 12^h 10^m to 13^h 30^m, and counted 17 meteors, of which 15 were Geminids. They were all about 4th magnitude, with short paths, and several of them appeared to be almost stationary.

The Fireballs of 1899.

A considerable number of these beautiful objects were observed in England during the year. The real paths of those which were recorded with sufficient fullness and precision have been computed, and the details are included in the table. But the majority of the large meteors have escaped adequate notice at the hands of observers, and are therefore quite lost to us, for no particulars can be preserved except the bare date and hour of their apparitions. Regular meteoric observers often miss fireballs which are apt to come into view at odd times, and often when least expected, as, for example, the large daylight meteor of January 9, 1900, 2^h 55^m p.m. In many cases we must necessarily depend upon outside help for the materials wherewith to investigate the paths of these bodies though the descriptions of persons possessing little astronomical knowledge or training is seldom of much utility. The assistance of astronomical observers generally would be very valuable in this field. Whenever a fireball is seen its apparent course amongst the stars, and estimated duration of flight, should be carefully recorded. In reporting the observation the R.A. and Dec. of the beginning and end points of the course should be given, as these figures can be more expeditiously dealt with than in cases where star names are mentioned. Mistakes are frequently made in the Greek letters, the computer sometimes has a difficulty in identifying a small star named, and sometimes becomes doubtful as to the meaning of the observer.

The radiant points derived from multiple observations of really well-observed fireballs and shooting stars afford important evidence upon some interesting points of meteoric astronomy. Observers will, therefore, perform a useful service to this branch in recording such bodies, whenever they are seen, as fully and correctly as possible.

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Fireballs have often been remarked as numerous at the opening of March, and in 1899, March 1, two very fine Geminids were seen by Mr. Astbury and several other observers.

On April 4 there was a brilliant Librid, but it was not well seen, and the path derived is somewhat doubtful. June 2 brought us a Venus-like Scorpiid, but it could not be accurately followed in the strong twilight. This radiant in Scorpio has often attracted attention from the very large meteors it yields near the time of midsummer. Its activity is not, however, confined to June, for bright meteors are directed from the same centre from early in May to the closing days of September.

About 10 very brilliant meteors were observed by those who watched the return of the August display. They were Perseids, as bright as, or brighter than, Venus, which lit up the sky with strong flashes, and left vivid green streaks, enduring for intervals from 30 seconds to 3½ minutes.

But the best observed fireball of the year was that which appeared in the early evening of August 24. It was a fine Pegasid, and the Director collected 49 accounts of it. It moved nearly E. to W., at normal heights, over the North Sea. Another fireball was seen at a later hour on the same night, and this, with a similar object widely observed in England on August 27, came from a radiant at 191° + 32°.

Unusually large meteors were also recorded on September 2, 8, and October 2, which admitted of satisfactory discussion.

A fireball appeared during the Leonid watch on November 14, at $17^h\ 4^m$, and left a streak for five minutes. It was seen by many observers, though but one or two troubled to record its apparent course. Fortunately the excellent places furnished by Sir W. J. Herschel, at Littlemore, near Oxford, enabled the real path to be determined, and the meteor proved to be from a similar radiant in Canes Venatici (S. of Cor. Caroli) to that which supplied the fireballs of August 24 and 27.

Several brilliant Leonids were interspersed among the comparatively few meteors which the celebrated mid-November stream furnished this year. On November 15, at about $16^h\ 50^m$, two Venus-like Leonids appeared almost simultaneously, and were noticed at many places.

In concluding this part of the subject we may mention the great Russian meteor of March 12, 1899. It fell to the earth near Burbely, a village 14 miles from Borgo. The pieces were collected, and weighed 850 lbs., the largest fragment being 206 Russian lbs. The meteor appeared between 9 and 10 p.m., and those who witnessed its descent say the sky was suddenly lit up with a bluish-white glare like the electric light. "The nucleus was a "flaming mass, of irregular form, surrounded by a nebulous veil, "and with a train depositing small red stars." Prof. Herschel has compared a number of descriptions and finds that the radiant point was in about 105°—20°. The direction of motion was from a little E. of S., and the aerolite in its flight of about 200 miles passed nearly over Dorput and Wisenberg, and thence over the Gulf of Finland to its earth point near Borgö. The "Daily Graphic" of April 17, 1899, gave a sketch of the cavity caused by the fall of the meteor, which is stated to have been some 12 feet in diameter and 27 feet deep.

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Radiant Points of Meteoric Showers, 1899.

B.A.A. Ref. No.	Date.	Name.	Radiant Point. α ° δ °	No. of Meteors.	Class.	Observer.
	1899.					
853	Jan. 4 - -	α Leonids -	154½ + 12	4	VR	W. E. B.
854	May 3-5 -	α Canum Ven.	194 + 46	5	S	E. R. B.
855	„ 3-7 -	π Herculids -	255 + 37½	7	ST	E. R. B.
856	„ 3-7 - -	ε Bootids -	218 + 24	6	R	E. R. B.
857	„ 3-7 -	γ Draconids -	267 + 50	5	R	E. R. B.
858	„ 3-7 - -	γ Delphinids -	308 + 16	5	RK	E. R. B.
859	„ 4-5 -	α Coronids -	232 + 23½	6	SB	E. R. B.
860	„ 4-7 - -	ζ Bootids -	216½ + 18	9	S	E. R. B.
861	„ 3-9, 1894-99.	ξ Ursids - -	173 + 29	6	S	A. S. H.
862	May 3-9 -	α Virginids -	204 − 3	7	SB	A. S. H.
863	„ „ - -	θ Bootids -	208 + 52	7	—	A. S. H.
864	„ „ -	ζ Librids -	230 − 20	4	M	A. S. H.
865	„ „ - -	θ Coronids -	232 + 32	7	—	A. S. H.
866	„ „ -	β Triangulids	24 + 32	5	RK	A. S. H.
867	„ „ - -	θ Draconids -	245 + 55	6	—	A. S. H.
868	„ „ -	α Scorpiids -	252 − 24	4	—	A. S. H.
869	„ „ - -	ψ Draconids -	274 + 75	8	SB	A. S. H.
870	„ „ -	ε Sagittids -	288 + 12	6	VR	A. S. H.
871	„ „ - -	α Capricornids	304 − 12	5	—	A. S. H.
872	„ „ -	β Aquarids -	315 − 14	5	VRK	A. S. H.
873	„ „ - -	Vulpeculids -	318 + 24	5	—	A. S. H.
874	„ „ -	μ Cygnids -	325 + 30	5	R	A. S. H.
875	„ „ - -	γ Aquarids -	335 − 1	4	VRK	A. S. H.
876	June 29-July 8 -	η Pegasids -	333½ + 27	6	R	A. S. H.
877	„ „ -	λ Aquilids -	283 − 14	6	S	A. S. H.
878	July 4-16 -	ω Draconids -	273 + 68	5	R	W. F. D.
879	July 28-Aug. 14	ζ Cassiopeids -	2 + 48	13	—	A. K.
880	„ „	β Cassiopeids -	359 + 59	5	M	A. K.
881	July 30-Aug. 14	γ Andromedids	21 + 40	5	R	A. K.
882	„ 30- „ 11	β Andromedids	16 + 31	4	RK	W. F. D.
883	„ 30- „ 13	δ Aquarids -	339 − 11	8	S	W. F. D.
884	„ 31- „ 12	ε Pegasids -	325 + 9½	6	R	A. K.
885	„ 31- „ 14	α Ursæ Min. -	{ 0 + 90 / 85 + 87 }	7	R	A. K.
886	„ 31- „ 13	δ Cassiopeids -	{ 18 + 59 / 25 + 62½ }	10	K	A. K.
887	„ 31- „ 16	β Piscids -	345 ± 0	9	M	W. F. D.
888	Aug. 1-12 -	δ Cassiopeids -	17½ + 58	5	—	J. H. B.

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B.A.A. Ref. No.	Date.	Name.	Radiant Point.	No. of Meteors.	Class.	Observer.
	1899.		α ° δ °			
889	Aug. 1–11	β Cepheids	326 + 70	6	—	J. H. B.
890	„ 1–Oct. 2	β Piscids	345 + 1	6	S	A. K.
891	Aug.–Sept.	ι Andromedids	346 + 36	10	R	A. K.
892	„ „	φ Pegasids	356 + 20	6	R	A. K.
893	Aug. 6–16	κ Cepheids	315 + 77	10	M	W. F. D
894	„ 8–14	φ Andromedids	26 + 48½	12	RK	A. K.
895	„ 9–14	χ Perseids	32½ + 56	10	—	J. H. B.
896	„ 9–16	o Draconids	293 + 60	8	S	W. F. D.
897	„ 9–17	η Pegasids	332 + 27	8	M	W. F. D.
898	„ 9–14	Camelids	61 + 58	10	VRK	A. K.
899	„ 10–18	ω Draconids	277 + 70	15	S	W. F. D.
900	„ 10	ε Perseids	64 + 34	7	—	W. E. B.
901	„ 10–14	ζ Cassiopeids	4 + 51½	19	—	W. E. B.
902	„ 10–14	λ Aquarids	340 − 5	5	—	W. E. B.
903	„ 11–13	λ Andromedids	354 + 50	5	RK	A. K.
904	„ 11–16	ε Arietids	40 + 21	5	RK	W. F. D.
905	„ 13–17	α–β Perseids	47 + 44	6	RK	W. F. D.
906	„ 14–18	Vulpeculids	323 + 23	5	R	W. F. D.
907	Sept. 27–Oct. 8	β Perseids	40 + 38½	10	RK	A. K.
908	„ 27–Nov. 6	α Cetids	39 + 4	4	—	A. K.
909	Oct. 30– „ 1	β Andromedids	13 + 30	4	Short	A. K.
910	„ 30– „ 6	ζ Arietids	50 + 20½	4	SB	A. K.
911	„ 30– „ 6	β Perseids	41 + 40	6	RK	A. K.
912	Nov. 6–10	ε Taurids	52 + 8	40	M	A. S. H.
913	„ „	o Orionids	68 + 17	7	S	A. S. H.
914	„ „	Monocerotids	121 − 1	5	R	A. S. H.
915	„ „	σ Ursids	134 + 67	5	R	A. S. H.
916	„ 6–13	κ Leonids	143 + 29	6	RK	A. S. H.
917	„ 8–13	Arietids	48 + 26	6	R	J. H. B.
918	„ „	ρ Leonids	160 + 11	4	RK	A. K.
919	„ 8–15	ι–κ Ursids	132 + 46	4	VR	A. K.
920	„ '98 and '99	δ Cancrids	130 + 20	4	Long paths.	A. K.
921	„ 12–16	Leonids	150 + 23	5	RK	A. S. H.
922	„ 14	„	154 + 25	—	RK	I. F. H. C. Gregg.
923	„ 15	„	151½ + 22	7	VR	A. K.
924	„ 23–Dec. 1, 1899, &c.	κ Draconids	186 + 73	5	RK	W. F. D.
925	Dec. 8–9	δ Geminids	110 + 25	17	—	T. H. A.

Radiants of August Perseids were summarised in "Journal," Vol. IX., p. 430.

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REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1899.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1899.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Mar. 1	7 0	4×♀	73	28	53	21	Wolverhampton -	Shrewsbury -	119 + 31	β *Geminid*	T. H. A.; Sir W. J. H.; Rev. A. T. Fryer.
„ 1	8 49	2½—♀	58	22	39	10	Romford - -	Harlow, Essex -	119 + 33	β *Geminid*	T. H. A.; G. T. Davis; C. Parker.
April 4	7 59	2×♀	60	52	160	—	10 W. Whitehaven -	N. coast, Ireland -	202 − 10	α *Virginid*	R. Killip; C. Parker; Parry
June 1	9 20	4+2½	90	30	—	—	King's Lynn -	King's Lynn -	209 + 51	θ *Boötid*	3 observers.
„ 2	8 47	♀	61	51	170	Slow	Totnes -	S. George's Channel	250 − 23	α *Scorpid*	T. Harries; H. C., and others.
„ 29	10 33	3—1	66	42	49	—	14 miles E. Foulness Point.	Brentwood - -	330 + 26	η *Pegasid*	T. H. A.; J. H. B.
July 4	10 50	2	54	46	27	13	Halcombe, Sussex -	Richmond, Surrey -	281 − 16	*Aquilid*	T. H. A.; J. H. B., and W. F. D.
„ 8	10 42½	4	53	41	14	18	Windsor - -	Thame, Oxon -	316 + 48	α *Cygnid*	A. S. H.; J. H. B.
„ 8	10 55	3—1	46	42	14	10	Banbury, Oxon -	10 miles W. Northampton.	253 − 20	α *Scorpiid*	A. S. H.; J. H. B., and W. F. D.
„ 8	10 57	4—2	36	33	3	—	Quainton - -	Quainton - -	294 + 61	o *Draconid*	A. S. H.; T. H. A.
„ 13	10 55	3	75	69	15	21	Harlow - -	Clavering - -	283 − 13	λ *Aquilid*	T. H. A.; J. H. B.
„ 16	11 10	4	78	65	14	18	6 miles S.S.E. Oxford.	7 miles E. Oxford -	263 + 36	ρ *Herculid*	A. S. H.; W. F. D.
„ 29	11 9	4	55	54	12	13	Wantage - -	Buckland, Berks -	317 − 31	ζ *Capricornid.*	A. S. H.; W. F. D.
„ 29	11 13	2<1	62	47	17	27	Towcester - -	Daventry - -	323 + 34	ζ *Cygnid*	A. S. H.; W. F. D.
„ 29	11 51	4	68	57	25	33	——	---	3 + 10	γ *Pegasid*	A. S. H.; W. F. D.
Aug. 1	11 10½	3—2	68	50	59	—	Dunstable - -	Nuneaton - -	335 − 11	α *Aquarid*	J. H. B.; W. F. D.
„ 6	10 36	2½—2	78	60	33	33	Wolverton - -	Oxford - -	39 + 57	*Perseid*	T. H. A.; W. F. D.
„ 9	10 19	3—2	88	61	51	—	7 miles N. Leicester	Stratford-on-Avon -	40 + 57	*Perseid*	T. H. A.; T. E. R. P.; W. F. D.

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1870		h m											
Aug. 10		10 14	24—♀	76	40	54	—	Cheltenham -	Bridgwater -	41 + 57	*Perseid*	T. H. A.; T. E. R. P.; S. J. J.; W. F. D.	
" 10		10 54	24	97	51	79	—	Mildenhall, Suffolk	Chesham, Bucks -	45 + 58	*Perseid*		
" 11		11 38	1	75	53	38	38	Ilmington, Worcester.	Stroud - -	46 + 57	*Perseid*	A. S. H.; W. F. D.	
" 14		9 31	3—1	67	61	19	—	7 miles S.E. March, Camb.	10 miles N.N.W. Cambridge.	52 + 46	*α Perseid*	J. H. B.; I. F. H. C. Gregg.	
" 24		8 11	☽	77	27	118	17	N. Sea - -	N. Sea - -	345 + 14	*α Pegasid*	49 observers.	
" 27		10 13	<♀	68	47	143	25	Wigan - -	Cambridge - -	191 + 32	*β Coma Ber.*	6 observers.	
Sept. 2		12 48	3×♀	86	60	28	—	Shipston, Warwick.	Tewkesbury -	46 + 42	*α–β Perseid*	I. F. H. C. Gregg; W. F. D.	
" 4		8 13½	24—♀	87	21	52	34	Farnham - -	Havant, Hants -	311 + 79	*κ Cephеid*	A. S. W.; T. H. A.	
" 8		8 21	>♀	71	26	114	20	English Channel -	Alresford, Hants -	347 + 3	*β Piscid*	T. H. A.; A. King.	
Oct. 2		8 24	♀	67	45	88	13	12 miles N.W. Ilfracombe.	Newbridge, Radnor	284 — 17	*λ Aquilid*	J. P. H. Boileau; W. S. Price.	
" 5		10 55½	2	82	45	14	20	Leighton Buzzard -	Wendover - -	137 + 65	*σ Ursid*	A. S. H.; T. H. A.	
" 10		11 6	3—1	48	43	13	21	Kingston, Surrey -	Brentford, Middlesex	35 — 10	*ρ Cetid*	A. S. H.; J. H. B.	
" 16		8 37½	2—1	73	48	27	—	Wiley, Salisbury Plain.	12 miles S.W. Salisbury Town.	334 + 74	*β Cephеid*	T. H. A.; S. J. J.	
Nov. 10		13 16	4—2	58	46	18	18	5 miles S.E. Cheltenham.	10 miles N.E. Cheltenham.	55 + 5	*σ Taurid*	A. S. H.; W. F. D.	
" 10		13 37½	4	90	48	46	32	Godalming - -	Chobham - -	72 + 32	*ι Aurigid*	A. S. H.; W. F. D.	
" 13		15 13½	3—2½	65	35	40	57	22 miles S. of Newhaven.	12 miles N.N.W. Brighton.	130 — 20	*Monocerotid.*	A. S. H.; J. H. B.	
" 14		17 40	24—♀	71	42	46	—	Buckingham -	Shipston - -	193 + 27	*β Coma Ber.*	Sir W. J. H.; T. E. R. P.; W. C. Tetley and others.	
" 15		16 48	>♀	83	50	43	—	St. Anne's-on-Sea -	12 miles S.W. Ravenglass, Lancashire.	150 + 20	*Leonid*	R. Killip; A. L. Cortie.	
" 15		16 50	♀	82	45	49	—	Wigan - -	Blackpool - -	151 + 21	*Leonid*	A. C. Allen; R. Service; D. A. Lampleigh.	
" 19		8 3½	24	85	42	68	23	40 miles E. Hornsea, Yorks, coast.	Driffield - -	60 + 28	*ψ Taurid*	T. W. Backhouse; C. L. Brook.	

Mean height at beginning 69 miles, at ending 46 miles. Length of path 50 miles.

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REAL PATHS OF BRIGHT PERSEIDS. *Computed by* Lieut.-Col. G. L. TUPMAN, R.M.A.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Path.	Velocity per second.	Radiant Point.	Observers.
1899.	h m		Miles.	Miles.	Miles.	Miles.	α° δ°	
Aug. 9	10 32	1—♀	83	61	40	40	*48+57	J. H. B.; J. H. Clark.
„ 9	11 4½	>1—2	62	46	28	32	40+53	J. H. B.; W.F.D.
„ 10	11 2	1	76	60	24	34	45+57	T. H. A.; T. E. R. P.; W.F.D.
„ 10	11 31	1	63	50	23	25	45+57	T. E. R. P.; W. F. D.
10	11 35	>1—2	60	41	37	36	45+55	J. H. B.; W.F.D.
„ 11	11 10	2	77	53	39	44	*46+58	T. E. R. P.; S. J. J.; W.F.D.
Means	—	—	70	52	32	37		

* In these cases the exact places of the radiants are doubtful.

The abbreviations in this and preceding tables are :—

T. H. A. = T. H. ASTBURY, Wallingford.
E. R. B. = E. R. BLAKELEY, Dewsbury.
W. E. B. = W. E. BESLEY, London.
J. H. B. = J. H. BRIDGER, Farnborough.
H. C. = H. CORDER, Bridgwater.
W. F. D. = W. F. DENNING, Bristol.
S. J. J. = Rev. S. J. JOHNSON, Bridport.
A. S. H. = Prof. A. S. HERSCHEL, Slough.
A. K. = A. KING, Leicester.
T. E. R. P. = Rev. T. E. R. PHILLIPS, Yeovil.

BRIGHT METEORS OBSERVED DURING 1899.

Date.	Time.	Mag.	Remarks.
1899.	h m s		
Jan. 26	8 56 0	♀	From 178½° + 60° to 171½° + 54°. Colour bluish white streak 3° or 4°.—A. KING, Leicester.
„ 26	8 56 0	VB	From centrally between the two stars in the Bear's tail, towards ε Draco. After the meteor had burst the remains of it were visible in the bright moonlight like a great cloud for 4 or 5 secs. Path very short.—H. SHEPPARD, Bishop's Stortford.
Feb. 8	6 9 0	Vega	From W. of zenith towards Vega. The meteor came into view nearly half way between the zenith and Vega.—J. T. BIRD, Dublin.
„ 12	8 45 0	VB	Fell vertically in azimuth 70° W. of S., alt. 35° to 15°. Duration 2 secs.—Thos. HARRIES, Llanelly.
Mar. 1	7 1 0	Sirius	From 340° + 63° to 323° + 44°. Bluish white. Duration 2½ secs. No streak. Appeared to be in flames.—T. H. ASTBURY, Wallingford.
„ 1	7 0 0	4 + ♀	From a point 5° p., β Cassiopeiæ, nearly vertically to horizon (reached within 10° of horizon). Duration 2½ secs. Bluish at the bright end. Trail died out before head.—Sir W. J. HERSCHEL, Littlemore, near Oxford.

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Date.	Time.	Mag.	Remarks.
1899.	h m s		
Mar. 1 -	6 50 0	VB	Descended in a line apparently parallel to the lower part of Ursa Major, as then in the heavens. Path curved. Meteor very light blue in body but ending in brilliant red of a deep tone like the red which a winter sun shows in setting. The nucleus was peculiar, almost fish-shape.—Rev. A. T. FRYER, Bridgend.
" 1 -	8 45 0	♀	From 187½° + 40½° to 205° + 35°. Duration 1½ sec. No sparks or train.—G. T. DAVIS, Reading.
" 1 -	8 51 0	♃	From 168° + 33° to 191° + 25°. Yellowish. Duration 4 secs. Dilated thrice towards end.—T. H. ASTBURY, Wallingford.
" 1 -	8 50 0	>♀	From about α Leonis to δ Crateris. Whitish trail.—C. PARKER, Handsworth, Birmingham.
" 1 -	10 27 0	1	From 112½° + 25° to 108½° + 8°. Greenish. Duration 1 sec.—A. King, Leicester.
" 5 -	18 7 0	2 × ♃	Below ♃ moving S.E. towards Saturn. 4 secs.—F. H. WRIGHT, North Hants.
" 6 -	17 45 0	Fireball	Great detonating meteor passed over Nashville, Tenn. It travelled a little W. of N., leaving a brilliant trail of blue light and sparks in its path. About 2 mins. afterwards three distinct explosions were heard, the first louder than the rest. This was followed immediately by a rumbling noise and a shaking as if of an earthquake. The shock was not violent enough to cause any damage but it made windows and doors rattle.—Newspaper cutting from E E. BARNARD, who was in Nashville at the time.
" 9 -	7 6 0	>♀	From N.W. alt. 35° to S., falling vertically, disappearing close to horizon. Rapid. Blue colour. Head pear-shaped.—C. F. SMITH, Edinburgh.
" 14 -	9 57 0	♃	At π Leonis. Course ½° downwards.—Rev. S. J. JOHNSON, Bridport.
" 23 -	9 30 0	Fireball	Emanated from Leo, and disappeared midway between the moon and horizon. When it had travelled about three-fourths of its course it divided into three parts, from behind, and appeared like three meteors, the second and third being the size of a tennis ball and an egg respectively, and of the brightness of stars of the 1st and 2nd mag., while the original seemed about the size of a child's football, and grew in brilliancy until it expired.—J. BROWN, Wincanton, Somerset.
" 23 -	9 30 0	VB	At Tiverton, Devon, two stars shot across the sky from E. to W., one was apparently much larger than the other, the larger taking precedence.
" 31 -	11 12 0	VB	Head 1½° by 15′. Died out about 30° above the N.E. horizon. Directed from S.W. by S. Duration about 10 secs.—G. T. DAVIS, Reading.
Apr. 4 -	7 56½ 0	2 × ♀	From α Cassiopeiæ, crossed φ Andromedæ, and disappeared 8–10° above W.N.W. horizon. Bluish streak. Pear-shaped nucleus. Caused a very sudden and brilliant illumination of the firmament.—Rev. R. KILLIP, St. Anne's-on-Sea.
" 4 -	7 59 0	>♃	From η Ursæ Majoris to β Cassiopeiæ, and 1° beyond the latter star.—C. PARKER, Handsworth, Birmingham.
" 4 -	11 51 0	Sirius	From 215° + 64° to 188° + 41°. Moved slowly.—A. S. HERSCHEL, Slough.
" 4 -	8 0 0	2 × ♀	From a little below α Cassiopeiæ to β Andromedæ. Broke into pieces.—R. PARRY, Hoole, Chester.

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Date.	Time.	Mag.	Remarks.
1899.	h m s		
Apr. 5	10 12 0	Sirius	Directed from about ϵ Hydræ, disappeared at 103°–6°. Course, 4°.—T. W. BACKHOUSE, Sunderland.
„ 8	10 5 0 (Local Time)	VB	Fireball observed at Delhi, starting from the N. and falling to the S. horizon. It left a red trail. The phenomenon was one of dazzling brilliancy. About a dozen smaller meteors were seen about 15 minutes before and after the fireball.
„ 15	9 51 0	<1	Started at o Ursæ Majoris, took a curiously curved path to the E., and vanished 10° E. of Capella. Duration, 3½ secs.—Rev. S. J. JOHNSON, Bridport.
„ 19	12 2 0	2½×1	Magnificent meteor moving from about 209° + 5° to 190°—26°. Pale green colour. Observer missed the beginning, but his attention was attracted by the startling flash of light in the S. There was thin cirro stratus cloud over the sky and bright moonlight.—Rev. T. E. R. PHILLIPS, Yeovil.
„ 27	8 20 0 (Local Time)	3 × 1	Fell about 23° E. of the moon, and was slightly inclined W. Disappeared behind trees when close to horizon.—E. G. ROBERTS, Masulipatam, India.
May 6	11 13 0	1	From 192½° + 40° to 181½° + 31°. Swift. Duration, ½ sec.—A. KING, Leicester.
„ 27	8 53 0	3 × 1	From 246° + 26° to 252° + 16°. ¾ secs. Died out suddenly without explosion.—T. H. ASTBURY, Wallingford.
„ 28	10 38 0	1	Fell under the Polar star, in the direction of Cassiopeiæ. Visible 5 to 7 secs. Left a bright trail of light.—Miss AGNES FRY, Failand, near Bristol.
„ 28	10 30 0	1	Passed κ Herculis, and directed downwards half way between β and ζ Herculis.—H. CORDER, Bridgwater.
June 1	9 20 0	VB	From near β Draconis, and fell in a vertical line to within 15° of the horizon. Colour bluish white, inclining to orange. Visible flight lasted 3 secs., and the luminous streak it left soon broke up and disappeared.—P. K., Kettering.
„ 1	9 18 0	4 × 1	From slightly E. of S.E., fell straight down from a great altitude. Colour pale gold, short tail. Duration, 2 secs. Obs. at Dewsbury.
„ 1	9 20 0	VB	Fine meteor, burst like a rocket near Cassiopeiæ. Short train.—W. LUCKING, Bishop's Stortford.
„ 2	8 45 0	♀	From Leo, towards due W. to 30° above horizon. Colour pure white. Duration, 4 secs. Its path was curvilinear, resembling that of a projectile when thrown up at a small angle.—T. HARRIES, Llanelly.
„ 2	8 40 0	VB	Small globe of light like a clear electric ball, travelled quite slowly from E. to W., descending gradually until it seemed to go out. Visible 2 or 3 secs. Not very high in the heavens.—Miss JESSIE M. EVANS, Weston-super-Mare.
„ 2	8 55 0	4 × 1	Probable course from about β Leonis, perhaps higher, down to N.W. horizon just over position of sun. Two Observers at Bridgwater.
„ 5	10 12 0	Sirius	From 258° + 23° to 262° + 12°. Colour red, changing to blue. Brilliant white flash at end as bright as Jupiter. Duration, 1½ sec.—T. H. ASTBURY, Wallingford.
„ 5	10 11 0	1	Path from Draco into Corona.—R. CROSS, Oxford.
„ 8	12 28 0	♀	From 87° + 69° to 118° + 59°. Green. Faint train.—A. KING, Leicester.
10	13 53	Sirius	At 28o°—14°. Seen through a tree.—T. W. BACKHOUSE, Torquay.

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Date.	Time.	Mag.	Remarks.
1869.	h m s		
June 10 -	9 11 0	5 × ♃	Moved from S. to S. by W., and alt. about 35° to 30°. Swift, rather short course. Burst into two, the first part shooting ahead and becoming red before extinction. Colour bluish white.—A. L. CORTIE, S.J., Stonyhurst.
July 12 -	9 40 0 (Local Time)	>♀	Started just under α Cygni, traversed N. side of Milky Way, and vanished just under ξ Cassiopeiæ. Very slow motion, The head was divided into three portions.—Rev. T. H. FOULKES, Kandia, Crete.
„ 29 -	9 20 0	2 × ♀	Falling from 5° below ε Cassiopeiæ to 5° above Capella. —W. J. STANTON, Stroud, Gloucestershire.
„ 29 -	10 54 0	Sirius	From 43° + 37° to 60° + 47°. Rather swift. 1½ secs. —A. S. HERSCHEL, Slough.
„ 30 -	12 42 0	♃	From 245° + 30° to 215° + 32°. Slow. Aquarid.— W. F. D., Bristol.
„ 31 -	10 53 0	>♃	From 118° + 71½° to 118° + 68°, Got brighter to end and then burst, when it was nearly = ♀. Duration, 0·7 sec.—A. KING, Leicester.
„ 31 -	11 3 0	>♃	From 336½° + 16½° to 341½° + 31½°. Train. Aquarid. 1½ secs.—A. KING, Leicester.
„ 31 -	11 5 0	ν B	Large fireball moving S.E. to N.E. Finishing under square of Pegasus.—C. PARKER, Handsworth, Birmingham.
Aug. 4 -	9 46 0	5 ♓ ♀	From 241½° + 23° to 218½° + 25°, when it burst, and finally disappeared in 208° + 22½°. [Probably a fine Aquarid.]—E. M. ANTONIADI, Juvisy.
„ 4 -	12 57 0	>♀	From 70° + 38° to 76° + 30°. Duration, 1 sec.—G. T. DAVIS, Reading.
„ 18 -	8 9 0	♃	Course from about 15° E. of Arcturus to a point 10° above Jupiter. Rev. S. J. JOHNSON, Bridport.
„ 24 -	8 11 0	½ = ☽	From 352° + 13½° to 2° + 12½°. Duration, 3 secs. Yellowish white, leaving sparks of a red hue. Twilight and rising moon obscured some of the stars, but it was just possible to make out γ Pegasi, below which the fireball appeared.—C. L. BROOK, Meltham, Huddersfield.
„ 24 -	8 11 0	♀	Dropped out of Perseus in N.E., and moved towards Capella, but not so far as that star. Motion slow. Duration, 5 or 6 secs.—E. W. JOHNSON, South Croydon.
„ 24 -	8 13 0	2 × ♀	From β Andromedæ to horizon below Capella. Reddish, leaving trail, then burst into bluish white.— S. H. E. SALMON, South Coydon.
„ 27 -	10 11 0	½ = ☽	From N.W. to S.E. Deneb Cygni to Aquarius, where it suddenly disappeared. Bright yellow. Duration, 4 secs. A magnificent pear-shaped fireball.—J. L. WHITTLE, Manchester.
„ 27 -	10 15 0	VB	From Ursa Majoris, through Auriga and Perseus. Duration, 4 secs. Lieu.-Col. J. P. H. BOILEAU, M.D., Trowbridge.
„ 27 -	10 15 0	VB	From N.W. to S.E. Moved slowly. Two Observers at Birmingham.
„ 27 -	9 15 0	♀	From 216° + 38½° to 201½° + 32½°. Slow.—W BESLEY, London, S. W.
„ 28 -	9 30 0	♃	From 302½° + 13½° to 315½° − 5. Slow. Train. 1 sec. —W. E. BESLEY, London, S.W.
„ 28 -	12 35 0	= ☽	From 292½° + 17° to 301° + 3°. Slow. Train. ½ sec.— W. E. BESLEY, London, S.W.

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Date.	Time.	Mag.	Remarks.
1899.	h m s		
Sept. 2 -	12 4½ 0	3 × ♀	From 40° + 67° to 37° + 74°. Rather swift. Lit up the sky, and left a streak for 1 minute.—W. F. D., Bristol.
„ 2 -	12 5 0	>♀	From 15° + 45° to 345° + 40°. Magnificent meteor. Very swift, trail visible for 1 min. in middle of path. Colour bluish white.—IVOR F. H. CARR GREGG, Great Malvern.
„ 4 -	8 9 0	α Lyræ	From 265° + 52° to 271° + 19°. 1½ sec. Bluish white, with red sparks.—A. S. HERSCHEL, Slough.
„ 4 -	8 13 0	♀	From 220° + 35° to 217° + 35°. 2 secs. Rather slow.—A. S. WILLIAMS, Hove.
„ 4 -	8 14 0	♃	From 297° + 28° to 296° + 13°. Yellow, bright streak. T. H. ASTBURY Wallingford.
„ 8 -	8 24 0	>♃	From S.E. to S.W. Bluish green. Splendid meteor.—C. PARKER, Handsworth.
„ 8 -	8 21 0	>♀	From 313° + 4° to 287° + 4°. 2½ secs. Bluish white. Slight train. Flashed out brilliantly 4° from end point.—T. H. ASTBURY, Wallingford.
„ 8 -	8 24 0	VB	Passed under μ and ε Aquarii at a little greater distance than that between β-η Pegasi, directed from 1° above γ or θ Piscium. It ended in a kind of explosion about 1½ the apparent visual area of the moon, but it was much veiled by clonds.—A. KING, Leicester.
„ 9 -	11 37 0	>1	From 67½° + 20° to 70° + 15°. Slow. Deep orange colour, head pear-shaped.—IVOR F. H. C. GREGG, Great Malvern.
„ 15 -	12 24 0	VB	From region of Pegasus to a little below the moon. Sky much clouded, and precise course could not be assigned. Motion rapid.—D. R. FOTHERINGHAM, Leith.
„ 17 -	9 0 0	VB	From β and γ Draconis to α-β Cassiopeiæ.—Lieut.-Col. BOILEAU, Trowbridge.
„ 27 -	10 33 0	>1	From κ Tauri, passing E. of Pleiades to about 20° beyond them towards α Trianguli. Left a broad trail.—JESSIE MCRAE, South Croydon.
Oct. 2 -	8 20 0	VB	From Corona Borealis to Ursa Major, disappearing below ε on a line drawn from γ to η. Shortly before going out it divided into two distinct portions, one following the other on the same line. Left a short train. Duration 4 or 5 secs.—Lieut.-Col. BOILEAU, M.D., Trowbridge.
„ 2 -	8 24 0	♃	Passed just above Ursa Major from about 207° + 63° to 144° + 62°. Nucleus of a decidedly deep yellow colour, and left a slight trail of short duration. Towards end of path meteor divided into 4 distinct fragments, so —●—●—●—>. The meteor travelled with exceptional slowness even for an object moving from W. to E.—W. S. PRICE, Wellington.
„ 2 -	11 6 0	>1	From 105° + 37½° to 112½° + 42°. Slow. Streak.—J. H. BRIDGER, Farnborough.
„ 8 -	6 3 0	VB	Appeared in S.W., alt. 30°, passed overhead, and disappeared in N.E. at alt. 30°. Colour, glistening primrose yellow with a bright golden tail about 3° long. When overhead it threw off two small portions which trailed behind and disappeared. Duration 10 secs.—J. H. BATEMAN, West Norwood.
„ 8 -	6 0 0	VB	Course S.W. to N.E. and exactly overhead; very slow, 8 to 9 secs. passing over. Just after crossing zenith it emitted two sparks. Left a long train.—W. NASH, Epsom.

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Date.	Time.	Mag.	Remarks.
1899.	h m s		
Oct. 8 -	6 0 0	VB	Travelled from S.W. to N.E. by E., and at a very slow speed. Visible 10 to 12 secs.—Correspondent of "Wellingboro' News."
„ 8 -	8 15 0	>1	From 47° + 51° to 119° + 74½°. Left a train, and occupied 2½ or 3 secs. in its flight.—A. KING, Leicester.
„ 8 -	11 40 0	VB	Small fireball. From 2° + 10½° to 32° + 10°. Very dull red colour. Perceptible disk. Streak. Duration 5 secs.—C. L. BROOK, Meltham, Huddersfield.
„ 10 -	10 17 0	♀	From 95½° + 63° to 222 + 85. Rapid. Streak. Orionid.—J. H. BRIDGER, Farnborough.
„ 11 -	11 16 0	♃	From 325° + 60° to 299° + 39°. Streak. Orionid.—A. S. HERSCHEL, Slough.
„ 16 -	10 1 0	2 × ♀	From 93° + 34° to 93½° + 57°. Rather slow, about 2 secs. It left a perfectly straight streak lasting about 1 sec. Colour = ♃. Orionid.—C. D. P. DAVIES, Chichester.
„ 25 -	10 8 0	>♀	From 127° + 77° to 180° + 86°. Moderate speed. Colour bluish white. Dense streak enduring 3 mins. and fading to an irregular oval shape.—J. H. BRIDGER, Farnborough.
„ 5 -	15 19 0 (Local Time)	♃	From midway between ζ Orionis and Sirius to near γ Leonis. Slow, yellow, and trained.—Capt. P. B. MOLESWORTH, Trincomali, Ceylon.
Nov. 10 -	13 8 0	Sirius	From 31° − 9° to 25½° − 14°. Slow.—A. S. HERSCHEL, Slough.
„ 13 -	13 8½ 0	Sirius	From 337° + 40½° to 330° + 35°. Swift. Streak.—A. S. HERSCHEL, Slough.
„ 12 -	9 50 0	VB	Fireball passed below the moon from N.E. to S.W. Very brilliant and pear-shaped. Greenish colour, and distinct trail. Speed moderate.—E. W. JOHNSON, South Croydon.
12 -	13 36 0	>1	From 134° + 82° to 72½° + 57. Rapid. Streak.—J. H. BRIDGER, Farnborough.
„ 14 -	17 40 0	♃	From 163° + 63° to 70° + 66°. Orange yellow. 2½ sec. Streak. Visible 5 minutes.—Sir W. J. HERSCHEL, Littlemore, Oxford.
„ 19 -	8 5 0	♃	From 73° + 35° to 86° + 42°. Small fireball. Yellowish white. Slow. 3 secs.—C. L. BROOK, Meltham, Huddersfield.
„ 19 -	8 6 0	♃	Directed from about Capella, disappeared at about 25° − 4°. Course 18°. Very slow. Duration 2 secs. Train about 8° long, more or less red. Head yellowish white.—T. W. BACKHOUSE, Sunderland.
„ 26 -	6 0½ 0	♃	From a point 1° above θ Cygni to a point 1° above 41 Cygni. (About 290° + 50° to 303° + 27).—Rev. J. JOHNSON, Bridport.
„ 26 -	10 32½ 0	♀	About 3° below τ^3 Eridani (54° − 27° to 53° − 31°). Greenish. At a low altitude.—Rev. S. J. JOHNSON, Bridport.
„ 27 -	9 20 0 (Local Time)	VB	From square of Pegasus to α Auriga. Just before this point the meteor divided into two, one going nearly into Cancer the other towards the Lynx.—C. N. NEUOFF, Sofia.
Dec. 1 -	11 25 0	>1	Path followed a line drawn from α Andromedæ through ν Cygni, originating a little distance beyond the latter star and towards the N. Path about 8° or 10° towards N. horizon. Deep orange colour.—W. S. PRICE, Wellington.

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Date.	Time.	Mag.	Remarks.
1893.	h m s		
Dec. 10 -	18 0 0	VB	Just before this time a brilliant meteor with long train was seen here passing from E. to N.W.—Miss J. E. A. BROWN, Cirencester.
„ 10 -	17 45 0	VB	Large ball of fire fell in S.E. Compared to its brilliancy "the electric light was nowhere." It appeared in about alt. 45°, and burst after a vertical descent. Description given to Mr. H. W. SMITHIES by a Chelmsford carpenter.

The abbreviation "VB" in 3rd column signifies Very Bright.

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SECTION FOR THE OBSERVATION

OF THE

COLOUR OF STARS.

DIRECTOR.—G. F. CHAMBERS, F.R.A.S.

A CATALOGUE OF RED STARS FOR 1900.

On an ordinary naked-eye view, the vast majority of the stars may be said to shine as silvery white points, though here and there a red or reddish star may be noticed. It would seem, however, that a very considerable number of stars visible to the naked eye, and which do not attact notice by their colour, are distinctly "red," "reddish," or "orange," when looked at through a telescope. It is possible that in some cases a metallic mirror may have the effect of exaggerating the normal ruddiness of a given star; and this may, to some extent, account for the strong language sometimes used by Sir J. Herschel ("ruby," "carmine," &c.). But making every allowance for merely instrumental effects, the fact seems certain that a telescope of any sort brings out extra colour beyond that which the unaided eye is able to appreciate.

Regarded simply as a spectacle, there can be no doubt that a strongly coloured red star is rather a fascinating object, and so much the more nowadays than formerly in consequence of the undoubted fact that so many variable stars are red, or, to put it the other way, that so many red stars are variable.

Perhaps Espin does not go too far when he makes the broad statement "that almost all the very red stars are variable to a "considerable extent seems to me an established fact."

No attempt has been made to render this catalogue, in the strict sense of the word, exhaustive. It is not a catalogue of all the stars which have been reported in print as red, but only of those which, by a fair concurrence of testimony, may be regarded as entitled to be called such. It, therefore, comprises no more than 584 out of, perhaps, 1500 which have been drawn upon.

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The following is an enumeration of the catalogues of reputed red stars which have been published up to this date :—

1804. LALANDE, J. DE. *Tables des Étoiles Rouges.*
(*Connaissances des Temps*, An. xv., p. 378.)

1822. DE ZACH, Baron. *Étoiles Rouges.*
(*Corresp. Ast.*, vol. vii., p. 298.)

1847. HERSCHEL, Sir J. *Ruby-coloured or very Intense Red Stars.*
(*Cape Observations*, p. 448.)

1866. SCHJELLERUP, H. C. *Catalog der rothen, isolirten Sterne.*
(*Ast. Nach.*, vol. lxvii., No. 1591, June 18, 1866; Addenda, vol. lxviii., No. 1613, October 30, 1866.)

1872. SCHMIDT, J. F. J. *Verzeichniss rothgelber Sterne.*
(*Ast. Nach.*, vol. lxxx., No. 1902, September 5, 1872.)

1874. SCHJELLERUP, H. C. *Zweiter Catalog der rothen, isolirten Sterne.*
(*Vierteljahrsschrift der Astronomischen Gesellschaft*, vol. ix.)

1876. BURNHAM, S. W. *Catalogue of Red Double Stars.*
(*Month. Not.* vol. xxxvi., p. 331, 1876.)

1877. BIRMINGHAM, J. *Observations and Catalogue of Red Stars.*
(*Trans. Roy. Irish Acad.*, vol. xxvi., p. 249, 1877.)

1877. FEARNLEY. *Des Étoiles colorées.*
(*Ast. Nach.*, vol. lxxxix., No. 2121, March 27, 1877.)

1879. LINDEMANN, E. *Verzeichniss von 42 neuen rothen Sternen.*
(*Bulletin de l'Acad. de St. Pétersbourg*, vol. xxv., p. 155.)

1882. DREYER, J. L. E. *Mean places of 321 Red Stars for 1875.*
(*Dunsink Observations*, pt. iv., 1882.)

1882. HOLDEN, E. S. *Observations of 84 Red Stars and a list of 27 new Red Stars.*
(*Washburn Observatory Publications*, vol. i., p. 161.)

1882. LINDEMANN, E. *Zweites Verzeichniss neuer rother Sternen.*
(*Bulletin de l'Acad. de St. Pétersbourg*, vol. xxviii., p. 278.)

1884. HOLDEN, E. S. *Observations of 119 Red or Coloured Stars.*
(*Washburn Observatory publications*, vol. ii., p. 102.)

1885. ESPIN, Rev. T. E. *Some New Red Stars.*
(*Journal of Liverpool Ast. Soc.*, vol. iii., p. 82, March 1885.)

1886. ESPIN, Rev. T. E. *Some New Red and Orange-red Stars.*
(*Month. Not. R.A.S.*, vol. xlvi., p. 293, March 1886.)

1888. BIRMINGHAM, J., and ESPIN, Rev. T. E. *The Red Stars: Observations and Catalogue.*)
(*Royal Irish Academy*, Cunningham Memoirs, No. 5.)

1893. KRUGER, F. *Catalog der farbigen Sterne zwischen dem Nordpol und 23 Grad Sudlicher Declination.*
(*Publication der Sternwarte* in Kiel, No. viii.)

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A few stars have been brought under my notice by private correspondents, and a few have been picked up from various general catalogues where casual mention has been made of this, that, or the other star as being "red." With certain exceptions variable stars have not been included here because I did not wish to trench upon another and very important field of stellar work. The exceptions are in all cases stars of very pronounced colour.

The study of red stars has no very great basis of history behind it. Though, as recorded above, Lalande, De Zach, and (especially) Sir J. Herschel did something in this field, it is to the Danish astronomer, Schjellerup, that the credit is due of making the first comprehensive and organised attempt to bring together red stars into a catalogue by themselves on a large scale. His labours were worthily developed by Birmingham, of Tuam, Ireland, whose catalogue of 1877 remains the most exhaustive ever published. Espin's edition of Birmingham's catalogue contains a large amount of supplementary information, the spectroscopic part of which is of great interest and value. It is, however, matter for regret that Espin's principles of inclusion and exclusion seem to me less intelligible and defined than could have been wished. For instance, he does not include, writing in 1888, a certain number of his own stars put forth in 1885 and 1886 as "red," or "orange red," and no explanation is given of the motives which have prompted such omissions.

As regards the places of the stars, every endeavour has been made to give these with the utmost attainable accuracy so far as information was available. By far the larger number depend upon the *Nautical Almanac*, the *Berliner Astronomisches Jahrbuch*, Dreyer's *Dunsink Catalogue of Red Stars for* 1875, Stone's *Cape Catalogue for* 1880, the *Greenwich Ten-Year Catalogue for* 1880, Stone's *Radcliffe Catalogue for* 1890, Rambaut's *Dunsink Catalogue of* 1101 *Stars for* 1900, and F. Kruger's *Catalog der farbigen Sterne for* 1900.

When these failed, resort was had to Yarnall's *Catalogue for* 1860, Maclear's *Cape Catalogue for* 1850, and the two older *Radcliffe Catalogues*. Outstanding gaps were then filled up by resort to Espin's edition of Birmingham's *Catalogue*, and to a few miscellaneous sources of information which need not be particularised. Some residual uncertainties were kindly cleared up at the last by observations specially made for the purpose by Mr. W. H. Robinson at the Radcliffe Observatory, under the direction of Dr. Rambaut, the Radcliffe Observer, who also contributed a large number of notes on the colours of particular stars observed by himself and various assistants at the Radcliffe Observatory both before and since he was appointed Director.

Many persons have co-operated in accomplishing the results which this Catalogue may be said to bring to a focus, and the frequency with which the names recur in the column of "Remarks," is some index to the industry of the workers. I think that with very few exceptions, every star visible in England to the number of about 500 have been viewed by myself with my 6-in. refractor, and, therefore, I hold myself in some measure responsible for the quality of the work. Others must decide

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whether that quality is, on the whole, satisfactory or unsatisfactory. I cannot, however, but regret that no assistance has been rendered to me by any Australian observer, notwithstanding my endeavours to evoke such assistance. The stars in the Southern Hemisphere of greater N.P.D. than about 120°, depend for the most part on observations limited in number and somewhat antiquated in date. I can only hope that the publication of this Catalogue may stimulate some Southern work.

Just a final word on the principles of selection. As a rule, no stars below the 9th magnitude are included, because estimates of colour of stars below that magnitude are apt (I would even say are certain) to be somewhat illusory. The magnitudes in column 7 are in all cases taken from the "Harvard Photometry," where the star was to be found in that exceedingly interesting and important work. The Appendix of "Rejected Stars" is a bare record of what it professes to be. In Espin's edition of Birmingham will be found a large number of stars spoken of as "yellow" or "yellowish," which I did not submit to the Section for treatment, presuming, on Espin's authority, that there could be no pretext for treating them as red stars. This might suggest openings for future work in the domain of red stars.

I have in conclusion to thank the following gentlemen, Members of the Coloured Star Section and others, who have supplied the notes upon which (in addition to my own), this Catalogue is based :—Messrs. T. W. Backhouse, F. A. Bellamy, C. G. Brodie, G. T. Davis, W. H. Robinson, H. M. Whitley, and W. Wickham.

It may be useful for future work if I put on record (*see* next page) the blank form which was sent out to Members of the Section for use by them in recording their observations.

It has been found necessary (through considerations of time and labour involved) to discard some observations sent in grouped in constellations instead of in order of R.A., as requested on the Blank Form.

I have not hitherto taken any steps to deal with coloured stars other than red or orange stars, but an interesting field of work is open in regard to blue and green stars. These are of course very much fewer in number; still, there are such, and they will repay study and deserve to be systematically catalogued; and I trust this may ere long be done under the auspices of a new Director.

G. F. CHAMBERS,
Director of the Section.

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British Astronomical Association.

COLOURED STAR SECTION.

It will suffice if the "time of observation" is given in hours, and quarters, thus, $8\frac{3}{4}$. The state of the atmosphere should be noted as "Very Clear," "Fairly Clear," "Slightly Hazy," "Very Hazy": "Steady" or "Tremulous" may be added if deemed expedient. If Moonlight or Twilight is obtrusive enough to affect the observations that fact should also be noted, using the words "Slight" or "Considerable," as the case may be. Only Stars which are in the same constellation and of the same *Hour* of R.A. and were observed on the same occasion (be it 1st, 2nd, or 3rd) are to be included in the same form.

R.A._____
(Hour Only).

Colours to be noted thus:

Pale Orange	—O
Decided Orange	—OO
Reddish	—r
Pale Red	—R
Decided Red	—RR
Very Strong Red	—RRR

*Year*_____ *Place*_____ *Power of Eye-Piece*_____

*Name of Observer*_____ *Aperture of Telescope*_____

Constellation _____			*1st Observation.*	*2nd Observation.*	*3rd Observation.*	
NO. OF STAR IN CHAMBERS' CATALOGUE OF 1887: AND NAME, IF IT HAS A DISTINCTIVE NAME.	R.A.	DECL.				*Date of Observation.*
						Time of Observation.
						State of Atmosphere.
						Moonlight.
						Twilight.
	h. m. s.	° ′				ANY MISCELLANEOUS REMARKS.

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. i Birm. Cat., 1876.
		h m s	s	° ′	″			
1	33 Piscium	0 0 13	+3·1	− 6 15·9	+20·0	4·6	Orange. "Pale orange" (Davis). "Red" (*Uran. Arg.*).	—
2	ι Ceti	0 14 20	+3·0	− 9 22·7	+20·0	3·6	"Pale orange" (Chambers, Davis).	3
3	− Andromedæ	0 14 36	+3·1	+44 9·3	+20·0	8	Fine fiery red	4
4	− Cassiopeiæ	0 29 47	+3·8	+67 22·5	+19·9	6½	Pale red.	—
5	− Cassiopeiæ	0 31 59	+3·8	+67 5·5	+19·9	7½	Reddish.	—
6**	δ Andromedæ	0 33 58	+3·2	+30 18·8	+19·7	3·4	Orange. "Pale Orange" (Davis). "Deep yellow" (Whitley).	8
7	α Cassiopeiæ	0 34 50	+3·4	+55 59·3	+19·8	2·2	Fine yellow. "Decided orange, ? var. in depth of tint" (Davis). "Orange yellow" (Whitley).	9
8	β Ceti	0 38 34	+3·0	−18 32·1	+19·8	2·1	Golden yellow. "Pale orange" (Davis).	10
9	Arg. + 61 : 178 Cassiopeiæ.	0 45 17	+3·5	+61 15·6	+19·7	6½	Fiery orange	Suppl.
10	− Cassiopeiæ	0 46 55	+3·7	+69 25·0	+19·6	7½	Orange. "Red yellow" (Fearnley).	Suppl.
11	η Ceti	1 3 33	+3·0	−10 42·6	+19·3	3·6	Fine golden yellow. "Pale orange" (Davis).	16
12	β Andromedæ	1 4 8	+3·3	+35 5·5	+19·1	2·2	Red. "Pale orange" (Davis). "Not red" (Whitley).	17
13***	− Piscium	1 10 37	+3·2	+25 14·5	+19·1	7	Fiery red	18
14	− Andromedæ	1 12 3	+3·5	+47 9·3	+19·1	7	Slight tinge of red	20
15	− Cassiopeiæ	1 20 42	+4·0	+65 33·5	+18·9	7	Pale red	23
16	R Sculptoris	1 22 22	+2·7	−33 3·7	+18·7	Var.	"Orange red" (J. Herschel). "Brilliant scarlet" (Gould).	24
17	− Cassiopeiæ	1 26 52	+3·9	+60 7·6	+18·7	9	Decided red. In clus. 103 M.	26
18	α Eridani	1 33 59	+2·2	−57 44·7	+18·4	1	Red	28
19**	ν Piscium	1 36 13	+3·1	+ 4 58·9	+18·3	4·7	Orange. "Decided orange" (Davis).	29
20	− Andromedæ	1 37 30	+3·7	+50 6·5	+18·3	7½	Red	30
21	− Cassiopeiæ	1 48 31	+4·7	+69 42·7	+17·8	8	Fiery red	31
22	Arg. + 44 : 398 Andromedæ.	1 52 33	+3·8	+44 55·6	+17·7	8	Reddish.	—
23	3717 Lal. Ceti	1 55 29	−3·0	− 9 0·5	+17·6	6	Reddish.	—
24	− Persei	1 56 24	+3·9	+54 45·0	+17·6	8	Pale red	33
25**	γ Andromedæ	1 57 45	+3·7	+41 51·0	+17·4	2·2	Orange, with blue companion 10″ distant. "Pale orange; at times decided orange" (Davis). "Orange yellow" (Whitley).	34

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
26**	α Arietis	2 1 32	+3·3	+22 59·4	+17·1	2	Orange. "Pale orange; at times strongly tinted" (Davis). "Pale yellow" (Whitley).	35
27	Arg. + 0 : 352 Ceti	2 1 39	+3·1	+ 0 57·8	+17·3	8	Slight tinge of red. ? mag. ? var.	36
28	60 Andromedæ	2 6 57	+3·7	+43 45·7	+17·0	5·1	Orange. "Decided orange" (Davis).	37
29	— Andromedæ	2 11 48	+3·8	+44 44·8	+16·9	8½	Reddish	39
30**	o Ceti	2 14 18	+3·0	− 3 25·9	+16·7	Var.	Fiery red at and near max. "Deep orange" (Backhouse). "Reddish or pale red" (Davis).	40
31	Arg. + 56 : 583 Persei	2 14 57	+4·2	+56 41·3	+16·8	9	Fiery red. Between clus. 33 and 34 ♅ VI. ? δ	41
32	65 Andromedæ	2 18 56	+3·9	+49 49·6	+16·6	4·9	Good orange. "Decided orange" (Davis).	—
33	Arg. + 65 : 280 Cassiopeiæ.	2 29 25	+4·8	+65 18·6	+15·9	6	Deep orange	45
34	15 Trianguli	2 29 42	+3·6	+34 15·2	+15·9	Var. 5–8	Reddish orange; blue star near. "Decided orange" (Davis).	—
35	Andromedæ	2 31 10	+4·3	+56 36·7	+15·9	8	Pale red	46
36	855 Weisse Trianguli	2 38 0	+3·6	+31 56·8	+15·6	7½	Reddish; neb. h 257 *p*.	47
37	η Persei	2 43 84	+4·3	+55 28·8	+15·1	3·9	Orange. "Decided orange" (Backhouse). "Deep orange" (Whitley).	49
38	Arg. + 63 : 369 Cassiopeiæ.	2 48 9	+4·9	+63 55·5	+14·8	6½	Deep orange	51
39*	α Ceti	2 57 3	+3·1	+ 3 41·8	+14·3	2·7	"Decided orange." (Chambers, Davis). "Orange red" (Robinson). "Orange" (Whitley).	52
40	ω Persei	3 4 38	+3·8	+39 14·0	+13·9	4·7	Reddish yellow. "Pale orange" (Davis).	56
41	Arg. + 47 : 779 Persei	3 5 30	+4·1	+47 21·0	+13·8	7	Pale red; two small stars in the field, *sf*.	57
42	1014 B.A.C. Horologii	3 10 1	+1·5	−57 41·8	+13·6	7	Red	59
43	6048 Lal. Eridani	3 10 40	+2·9	− 9 8·3	+13·6	7	Reddish; *p*. ζ Erid. 18ˢ, and 4′ N.	58
44	W.B. III. 152 Eridani	3 11 25	+2·9	− 6 5·9	+13·6	7	Reddish orange. "Ruddy" (Robinson).	60
45	o Tauri	3 19 26	+3·2	+ 8 40·6	+12·8	3·8	Orange. "Deep yellow" (Davis).	—
46	Arg. + 54 : 685 Camelopardi.	3 22 34	+4·5	+55 1·7	+12·7	7½	Pale red	61

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No.	Name of Star.	R.A., 1900,	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour Remarks.	No. in Birm. Cat., 1876.
		h m s		° ′	″			
47	σ l'ersei - -	3 23 31	+4·2	+47 39·0	+12·7	4·4	Pale orange; contrasts with white stars near. "Decided orange" (Davis).	62
48	— Camelopardi -	3 33 11	+5·1	+62 19·5	+12·1	7	Pale crimson	65
49	Arg.+54 : 110 Camelopardi.	3 33 54	+9	+80 0·2	+12·0	7½	Red - - -	—
50	— Persei - -	3 38 27	+4·5	+53 35·4	+11·7	8½	Red - - -	67
51	121 P. III. Camelopardi.	3 40 11	+5·4	+65 12·9	+11·7	6	Deep orange. Mag. 4·75 (*Uran. Oxon.*) "Reddish" (Davis).	69
52	π Eridani - -	3 41 24	+2·8	−12 25·1	+11·5	4·4	Reddish orange. "Orange" (Davis).	70
53	42 Espin Tauri -	3 42 8	+3·5	+24 40·8	+11·40	7	Reddish orange.	—
54	1204 B.A.C. Camelopardi.	3 48 36	+5·1	+60 48·0	+11·0	5·1	Pale orange. "Decided orange" (Davis).	71
55	γ Hydri - -	3 48 47	−1·0	−74 32·7	+10·9	3½	"Deep yellow" (Williams).	—
56	7272 Lal. Eridani -	3 50 19	+2·7	−15 13·0	+10·7	8	Reddish orange. A larger star of same colour *sp.*	72
57	γ^1 Eridani - -	3 53 21	+2·8	−13 47·6	+10·4	3·0	Reddish orange. "Decided orange" (Davis). "Reddish" (Robinson).	—
58	Arg.+61 : 667 Camelopardi.	3 57 11	+5·2	+61 31·3	+10·3	7½	Decided red.	—
59	γ Reticuli - -	3 59 27	+0·8	−62 26·3	+10·0	4·7	"Deep yellow" (Williams).	—
60	Arg.+32 : 743 Persei -	4 6 36	+3·8	+32 16·4	+ 9·5	7	Fiery orange.	—
61	19 P. IV. Tauri -	4 9 24	+3·3	+ 9 45·3	+ 9·2	5½	"Orange or doubtful, may be violet" (Davis). "Red" (*Uran. Arg.*)	—
62	1342 B.A.C. Tauri -	4 16 29	+3·5	+20 35·1	+ 8·9	6½	Fiery orange. ? Var.	74
63	Arg.+34 : 874 Persei -	4 17 46	+3·9	+35 0·8	+ 8·9	7½	Red.	—
64	45 Eridani - -	4 26 45	+3·1	− 0 15·2	+ 8·0	4·9	Deep orange. "Pale orange" (Davis).	—
65	8623 Lal. Eridani -	4 28 38	+2·8	−10 59·8	+ 7·8	6·5	Reddish.	—
66*	47 Eridani - -	4 29 23	+2·9	− 8 26·4	+ 7·8	5½	Reddish orange. "Decided orange" (Davis).	—
67	W.B. IV. 585 Eridani	4 29 24	+2·9	− 9 10·5	+ 7·7	6	Fiery Red.	—
68	e (58) Persei -	4 29 44	+4·1	+41 3·5	+ 7·7	4·4	Golden. "Decided orange" (Davis).	80
69**	α Tauri - -	4 30 11	+3·4	+16 18·5	+ 7·4	1	Deep reddish orange. "Decided red" (Backhouse). "Deep yellow" (Whitley).	81
70	Arg.+21 : 1047 Aurigæ	4 38 14	4·2	+43 35·9	+ 7·0	8	Red.	—
71	— Aurigæ -	4 38 46	+3·9	+32 44·0	+ 7·0	8½	Pale crimson; a larger orange star *p.*	82

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
72*	1457 B.A.C. Camelopardi.	4 40 52	+6·2	+67 59·6	+ 7·0	7	Fiery red - -	83
73	Arg.+34 : 911 Aurigæ	4 42 38	+3·9	+34 49·5	+ 6·7	8	Red.	—
74	— Aurigæ - -	4 45 14	+3·7	+28 21·4	+ 6·5	8	Unmistakeably crimson.	85
75	Arg.+38 : 955 Aurigæ	4 45 47	+4·1	+38 20·0	+ 6·5	8½	Red.	—
76	o^1 Orionis - -	4 46 53	+3·4	+14 5·1	+ 6·4	5·4	Reddish orange. "Decided orange" (Backhouse; Davis). "Orange" (Whitley).	87
77	5 Orionis - -	4 48 8	+3·1	+ 2 20·6	+ 6·3	6	Deep orange. Probably var. "Decided orange" (Davis).	88
78	236 P. IV. Orionis -	4 49 22	+3·2	+ 7 37·1	+ 6·2	6	Deep golden yellow -	89
79	6 Aurigæ - -	4 53 29	+4·1	+39 30·4	+ 6·0	6½	Red - - -	91
80	3 Espin Aurigæ -	4 53 44	+4·1	+40 5·6	+ 6·0	7½	Fiery red, ? identity.	—
81**	R Leporis - -	4 55 3	+2·7	−14 57·7	+ 5·7	Var.	Decided crimson. "Crimson" (Wickham).	94
82	ζ Aurigæ - -	4 55 49	+4·2	+40 55·8	+ 5·7	4·0	Fine deep orange. "Orange" (Whitley). "Not deep orange" (Davis).	93
83	Arg.+34 : 946 Aurigæ	4 59 49	+3·9	+34 43·1	+ 5·4	8½	Reddish.	—
84	899 H.P. Orionis -	5 0 14	+3·1	+ 1 2·4	+ 5·3	7	Intense fiery red -	96
85	ε Leporis - -	5 1 13	+2·5	−22 30·3	+ 5·0	3·3	Reddish orange, ? var.	97
86	W.B. V. 29 Orionis -	5 4 53	+3·2	− 5 39·2	+ 4·7	8	Full red - -	99
87*	9785 Lal. Leporis -	5 6 43	+2·8	−11 58·4	+ 4·6	6½	Deep red. "Decidedly red" (Robinson). Espin and Gore's places are irreconcileable. This place is from *Rad. Cat.* of 1890.	—
88	Arg. −0 : 890 Orionis	5 9 31	+3·0	− 0 41·1	+ 4·4	7	Pale orange - -	102
89*	Arg.+40 : 1245 Aurigæ	5 11 55	+4·2	+40 58·8	+ 4·2	7½	"Red-orange" (Robinson). "Decided orange" (Davis).	—
90	Arg.+35 : 1046 Aurigæ	5 12 28	+4·0	+35 40·5	+ 4·2	8½	Fiery red.	—
91	— Aurigæ - -	5 13 10	+4·1	+39 14·3	+ 4·2	8	Pale red, ? var. in colour.	103
92	9919 Lal. Aurigæ -	5 14 14	+4·0	+34 10·0	+ 4·1	8½	Reddish - - -	104
93	Arg.+32 : 957 Aurigæ	5 15 18	+3·9	+32 24·3	+ 3·6	9	"Very red" (Espin).	—
94	61 P. V. Orionis -	5 16 50	+3·1	+ 3 28·4	+ 3·7	8	Red - - -	106
95*	Arg.−10 : 1178 Orionis	5 20 18	+2·8	−10 25·1	+ 3·5	6	Reddish orange. "Reddish" (Davis).	—
96*	Arg.+29 : 897 Aurigæ	5 20 46	+3·8	+29 50·3	+ 3·5	8	Almost pale ruby.	—
97	— Aurigæ - -	5 21 17	+3·9	+35 13·9	+ 3·4	7	Good orange. In clus. 39 ♅ VII.	—
98	117 Tauri - -	5 22 13	+3·5	+17 9·5	+ 3·3	6·5	Red.	—

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour : Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
99	8 Orionis - -	5 24 4	+2·9	− 4 46·3	+ 3·0	Var.	Reddish. In centre of small equilateral triangle of 3 stars.	109
100	31 Orionis - -	5 24 38	+3·0	− 1 10·2	+ 3·2	4·9	Deep orange. Var. 5–6? "Decided orange" (Davis). "Orange" (Whitley).	110
101	119 Tauri - -	5 26 20	+3·5	+18 31·2	+ 3·0	4·6	Pale red. "Distinctly red" (*Uran. Oxon.*). "Decided orange or pale red" (Davis).	111
102*	Arg.+32 : 1030 Aurigæ	5 27 11	+3·9	+32 40·5	+ 3·0	7	Reddish orange. Blue star, mag. 6, near.	—
103	10426 Lal. Orionis -	5 27 30	+3·0	− 0 3·6	+ 2·8	8	Decided red. "Red" (Robinson). ? mag. too small. *Rad. Cat.* of 1890 gives 6–7, and other authorities differ much.	—
104*	Arg. + 7 : 929 Orionis	5 27 49	+3·2	+ 7 4·3	+ 2·8	7½	Very red.	—
105	Arg. + 25 : 863 Tauri	5 28 39	+3·7	+25 49·5	+ 2·7	8½	Red.	—
106	10483 Lal. Orionis -	5 29 0	+3·0	− 1 32·3	+ 2·7	7	Fiery red.	—
107	ϕ^3 Orionis - -	5 31 24	+3·3	+ 9 14·2	+ 2·5	4·4	Orange. "Decided orange" (Davis). "Yellow" (Whitley).	113
108	— Orionis - -	5 31 30	+3·3	+10 58·6	+ 2·5	7	Reddish orange -	114
109	β Doradûs - -	5 32 45	+0·5	−62 33·3	+ 2·4	3·9	"Reddish yellow" (Williams).	—
110	124 Tauri - -	5 33 10	+3·6	+23 15·6	+ 2·4	7½	Quadruple star : A, red.	—
111	Arg.+31 : 1049 Aurigæ	5 34 11	+3·8	+31 51·8	+ 2·3	6½	"Orange red" (Espin).	—
112	Arg.+31 : 1058 Aurigæ	5 35 42	+3·9	+31 49·5	+ 2·2	8½	Fiery red.	—
113	10743 Lal. Orionis -	5 35 59	+3·0	− 3 53·7	+ 2·2	8	Reddish - -	117
114	51 Orionis - -	5 37 19	+3·1	+ 1 25·6	+ 2·0	5½	Orange. "Slightly red" (*Uran. Oxon.*) "Pale orange" (Backhouse, Davis).	119
115	— Tauri - -	5 39 6	+3·7	+24 22·6	+ 2·0	8½	Decided red, ? var. -	120
116	Arg.+50 : 1225 Aurigæ	5 39 32	+4·6	+50 2·9	+ 1·9	7	Reddish orange.	—
117	— Geminorum -	5 39 43	+3·6	+20 39·2	+ 1·7	7½	Good red, ? var. -	121
118	— Pictoris - -	5 40 27	+1·7	−46 29·9	+ 1·7	8	"Vivid red" (J. Herschel).	124
119	— Aurigæ - -	5 41 42	+3·9	+30 35·7	+ 1·7	8	Deep red. Probably var. in mag. and colour.	123
120	11061 Lal. Orionis -	5 44 53	+3·1	+ 4 24·1	+ 1·2	6	Deep orange.	—
121	Arg.+32 : 1109 Aurigæ	5 44 55	+3·9	+32 5·9	+ 1·2	6½	Fiery red. Near neb. 37 M.	—
122	56 Orionis - -	5 47 14	+3·0	+ 1 49·9	+ 1·0	5·0	Reddish orange. "Decided orange" (Davis).	—
123	Arg.+53 : 962 Aurigæ	5 47 30	+4·8	+53 26·4	+ 1·0	8	Red. = 58 Espin.	—

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No.	Name of Star.	R.A., 1906.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
124	Arg.+10: 927 Orionis	5 48 41	+3·3	+10 33·7	+ 1·0	6½	Golden yellow -	126
125	α Orionis - -	5 49 45	+3·2	+ 7 23·3	+ 0·9	0·9	Reddish orange. "Pale orange" (Davis). "Decided red" (Backhouse). "Reddish" (Robinson). "Deep yellow" (Whitley). Var.?	127
126	Gore's *Nova* Orionis	5 49 53	+3·6	+20 9·3	+ 0·9	6½	Fiery red. "Very red at times" (Wickham). ? Var. in colour.	—
127	δ Aurigæ - -	5 51 17	+4·9	+54 16·6	+ 0·9	3·3	"Pale orange" (Davis). "Deep yellow" (Whitley).	129
128*	π Aurigæ - -	5 52 29	+4·4	+45 55·7	+ 0·8	4·5	Reddish orange. "Pale orange" (Brodie). "Decided orange" (Davis). "Deep orange" (Whitley).	130
129	11451 Lal. Orionis -	5 57 12	+2·9	− 5 8·2	+ 0·3	7	Reddish yellow -	133
130	Arg.+47: 1258 Aurigæ	6 2 46	+4·5	+47 43·0	− 0·3	8	Red. = 158 Espin.	—
131	1970 B.A.C. Geminorum.	6 3 30	+3·6	+22 12·5	− 0·3	6·5	"Reddish" (Robinson).	—
132*	11684 Lal. Geminorum	6 4 39	+3·7	+26 2·1	− 0·3	7½	Good red - - -	135
133	Arg.+21: 1146 Geminorum.	6 5 51	+3·6	+21 53·5	− 0·3	7	Red - -	136
134	Arg.+22: 1220 Geminorum.	6 6 16	+3·6	+22 55·6	− 0·3	7	Red. Two red stars here. The smaller (mag. 7·7) precedes this one by 23 s. and is 18′ N.	137
135	η Geminorum -	6 8 51	+3·6	+22 38·2	− 0·7	3·5	Reddish yellow. "Pale orange" (Davis). "Orange" (Whitley). Var.	139
136	Arg.+17: 1191 Orionis	6 10 35	+3·5	+17 12·9	− 0·9	6·5	Orange. "Reddish" (Robinson).	—
137	Arg.+33: 1290 Aurigæ	6 10 39	+3·9	+33 14·5	− 0·9	9	Very red.	—
138	Arg.+39: 1576 Aurigæ	6 10 47	+4·2	+39 30·4	− 0·9	7½	Pale red. ? Var. -	141
139	12060 Lal. Canis Majoris.	6 13 15	+2·7	−16 46·7	− 1·1	5·1	Red. "Pale orange" (Davis).	—
140	2029 B.A.C. Geminorum.	6 13 18	+3·6	+23 18·9	− 1·1	7	Pale orange. "Magnificent spectrum."	—
141	12057 Lal. Orionis -	6 14 22	+3·4	+14 41·6	− 1·3	6	Reddish yellow -	142
142	12104 Lal. Orionis -	6 14 59	+3·0	− 2 54·1	− 1·3	6	Deep orange. "Decided orange" (Davis). ? Var.	—
143	Σ 895 Monocerotis -	6 15 27	+3·1	+ 5 47·1	− 1·4	8	Fairly red. "Orange red" (Robinson). *Comes*, Mag. 9·5, deep blue.	—
144	12169 Lal. Canis Majoris.	6 16 26	+2·8	−11 46·3	+ 1·4	7	Fiery red. Good contrast with 12176 Lalande (mag. 6) which follows 20ˢ, and 5′ N. (Robinson).	—

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		h m s	s	° ′	″			
145	160 Espin Aurigæ -	6 16 28	+4·5	+47 43·5	− 1·4	8½	"Red and probably var" (Espin).	—
146	μ Geminorum -	6 16 55	+3·6	+22 33·9	− 1·6	3·2	Reddish orange. "Decided orange" (Davis). "Orange" (Whitley).	143
147	Arg.+25: 1250 Geminorum.	6 17 51	+3·7	+25 4·9	− 1·6	9	Very red. "Red" (Robinson).	—
148	5 Lyncis - -	6 18 4	+5·2	+58 28·5	− 1·6	5·5	Fiery red. In a good group. "Decided orange" (Davis).	—
149	3 Canis Majoris -	6 18 28	+2·2	−33 23·7	+ 1·6	4·1	"Rich orange yellow" (Tupman).	—
150	— Canis Majoris -	6 19 40	+2·4	−27 0·8	− 1·6	8	Pale crimson. "Intense ruby" (J. Herschel). "Orange red" (Brodie).	145
151	— Geminorum -	6 19 45	+3·4	+14 46·6	− 1·6	7	Full deep orange. ? var.	144
152	12359 Lal. Monocerotis	6 22 0	+2·9	− 4 24·0	− 1·8	7	Deep orange. "Reddish?" (Robinson).	—
153	— Monocerotis -	6 25 26	+3·0	− 2 57·2	− 2·1	8	Orange. ? var.	147
154	12524 Lal. Canis Majoris.	6 25 50	+2·6	−19 8·8	− 2·2	6½	Orange. "Reddish" (Bellamy).	—
155	12545 Lal. Monocerotis	6 27 2	+2·9	− 8 5·2	− 2·3	5½	Reddish orange. "Decided orange" (Davis).	—
156	Arg.+16: 1194 Geminorum.	6 28 38	+2·7	+16 9·1	− 2·4	9	"Strikingly red" (Robinson).	—
157**	2139 B.A.C. Aurigæ -	6 29 39	+4·1	+38 31·6	− 2·4	6	Deep fiery red - -	148
158	Arg.−1: 1288 Monocerotis.	6 30 8	+3·0	− 1 25·6	− 2·4	8½	Fiery red. = 165 Espin	—
159	21 Espin Aurigæ -	6 31 21	+1·9	+39 29·0	− 2·6	6½	Reddish orange.	—
160	ν^2 Canis Majoris -	6 31 53	+2·6	−19 10·2	− 2·8	4·2	Orange. "Pale orange; uncertain" (Davis). "Red" (Robinson). "Deep yellow" (Whitley).	—
161	2196 B.A.C. Puppis -	6 36 10	+1·3	−52 50·7	− 3·1	6	"De Color rojizo" (Moesta).	150
162	12907 Lal. Monocerotis	6 37 10	+2·9	− 9 4·2	− 3·1	5½	"Orange. "Decided orange" (Davis).	151
163	ε Geminorum -	6 37 46	+3·7	+25 13·8	− 3·3	3·2	Golden yellow. "Decided orange" (Davis). "Yellow" (Whitley).	152
164	17 Monocerotis -	6 41 55	+3·3	+ 8 8·7	− 3·4	5	Reddish yellow. "Decided orange" (Davis).	—
165	— Canis Majoris -	6 42 44	+2·6	−20 33·3	− 3·5	8	Pale red. Near centre of clus. 41 M.	153

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166*	13100 Lal. Monocerotis	6 42 51	+ 2·9	− 8 53·3	+ 3·7	5½	Reddish orange. "Decided orange" (Davis). "Reddish" (Robinson).	—
167	Arg.+61 : 915 Lyncis	6 44 31	+ 5·4	+61 8·8	− 3·7	8	Red.	—
168	θ Canis Majoris -	6 49 32	+ 2·8	−11 54·8	− 4·3	4·2	Reddish orange. "Decided orange" (Davis). "Red" (Robinson). "Deep yellow" (Whitley).	156
169	o^1 Canis Majoris -	6 49 59	+ 2·5	−24 3·5	− 4·3	4·0	Deep orange - -	157
170	1228 Groom. Camelop.	6 50 0	+ 6·8	+70 56·6	− 4·3	6	"Orange" (Robinson).	—
171	μ Canis Majoris -	6 51 31	+ 2·7	−13 54·8	− 4·4	5·2	Fiery red. "Decided orange or reddish" (Davis).	158
172	2289 B.A.C. Puppis -	6 53 36	+ 1·6	−48 35·3	− 4·6	5·5	"De Color rojizo" (Moesta).	161
173	51 (Hev.) Cephei -	6 53 45	+29·7	+87 12·3	− 4·7	5·3	Full orange. "Pale orange" (Davis).	154
174	1245 Groom. Camelop.	6 54 32	+ 6·8	+70 52·6	− 4·5	6½	Pale red - -	160
175	13627 Lal. Monocerotis	6 57 2	+ 2·9	− 5 34·9	− 4·9	5½	Good orange. "Decided orange" (Davis). ? Var.	—
176	22 Canis Majoris -	6 57 44	+ 2·4	−27 47·5	− 5·0	3·5	Fiery red. ? Var. -	162
177	− Monocerotis - -	6 57 57	+ 2·9	− 8 18·4	− 4·9	8	Red. In clus. 50 M. -	163
178**	− Monocerotis -	7 2 5	+ 2·9	− 7 24·1	− 5·3	8	Crimson - -	165
179*	R Canis Minoris -	7 3 13	+ 3·3	+10 10·9	− 5·3	7–10 var.	Red - - -	167
180*	− Canis Majoris -	7 3 23	+ 2·8	−11 46·5	− 5·4	7½	Decided red - -	166
181	14038 Lal. Geminorum	7 9 35	+ 3·6	+22 8·5	− 5·9	7	Orange or pale red -	170
182	2326 B.A.C. Camelopardi.	7 10 4	+13·0	+82 36·3	− 5·6	5·3	Reddish orange. "Decided orange" (Davis).	168
183	L^2 Puppis - -	7 10 28	+ 1·8	−44 28·7	− 6·0	5	"Red and var." (*Uran. Arg.*)	—
184	14200 Lal. Canis Majoris.	7 12 23	+ 2·5	−23 8·2	− 6·2	6½	Wide pair. A, 6½ orange; B, 7 blue. "A, probably var." (Espin).	—
185	14184 Lal. Monocerotis	7 12 39	+ 2·9	− 6 30·1	− 6·2	6½	Reddish orange. "Reddish" (Robinson.)	—
186	π Argûs - -	7 13 36	+ 2·1	−36 55·0	− 6·3	2·7	"Beautiful orange" (Gore). "Very rich yellow" (Tupman).	171
187	−Monocerotis -	7 16 14	+ 2·8	−10 11·9	−6·5	8	Orange. "Pale orange" (Davis). *p* clus., h 443. ?.δ too little.	172
188	66 Aurigæ - -	7 17 13	+ 4·0	+40 52·0	−6·3	5·3	Orange.	—
189	−Canis Majoris -	7 18 52	+ 2·5	−25 34·5	−6·7	7	Red - - -	175
190	η Canis Majoris -	7 20 8	+ 2 3	−29 6·5	−6·9	2·4	"? Purple" (Tupman). "Pale red" (Smyth).	—

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		h m s	s	° ′	″			
191	Arg.+46: 1271 Lyncis	7 20 56	+4·4	+46 10·2	−6·9	8	Fiery red.	—
192	14503 Lal. Canis Majoris.	7 21 28	+2·6	−20 45·4	−6·9	8	Reddish - -	176
193	14599 Lal. Monocerotis.	7 24 37	+2·8	−10 7·2	−7·2	6	Reddish orange, ? var.	178
194	σ Argûs - -	7 26 3	+1·9	−43 5·9	−7·3	3·5	"Red" (Schmidt) -	179
195*	14776 Lal. Puppis -	7 29 12	+2·7	−14 18·4	−7·6	5·0	Fiery red. *p* a brilliant field. "Decided orange" (Davis).	—
196	υ Geminorum -	7 29 45	+3·7	+27 7·2	−7·6	4·2	Orange. "Decided orange" (Davis). "Deep orange-yellow" (Whitley).	181
197	25 Espin Lyncis -	7 30 19	+4·1	+40 14·5	−7·6	7	Reddish. The *p* star of a curious curve of 5 stars.	—
198	14952 Lal. Puppis -	7 34 53	+2·7	−16 37·0	−8·0	6	Pale red.	—
199	Arg.+23: 1780 Geminorum.	7 34 56	+3·6	+23 16·0	−7·9	6	Fiery red - -	182
200	−Canis Minoris -	7 35 33	+3·2	+ 4 18·3	−8·1	7	Reddish - orange. "Light orange" (Robinson).	—
201	γ Monocerotis -	7 36 28	+2·9	− 9 19·0	−8·2	4·2	Orange. "Pale orange" (Davis). "Reddish" (Robinson).	—
202	σ Geminorum -	7 37 3	+3·7	+29 7·5	−8·2	4·1	"Pale orange" (Chambers, Davis). "Orange" (Whitley). A small star *p* 39°.	183
203	15018 Lal. Monocerotis.	7 37 32	+2·8	−10 38·7	−8·2	7½	Pale red - -	186
204	Arg.+5: 1759 Canis Minoris.	7 38 4	+3·2	+ 5 10·8	−8·3	7	Pale red - -	187
205*	β Geminorum -	7 39 12	+3·7	+28 16·1	−8·4	1·1	"Pale orange" (Chambers, Davis). "Yellow" (Whitley).	188
206	*c* Puppis - -	7 41 40	+2·1	−37 43·5	−8·5	3·6	"Orange" (J. Herschel). The chief star in neb. h 3099 ? Var.	189
207	28 Espin Lyncis -	7 43 23	+4·0	+40 1·4	−8·6	7	Good red.	—
208	Arg.+5: 1797 Canis Minoris.	7 43 27	+3·2	+ 5 40·4	−8·6	9	Good red.	—
209	ξ Argûs - -	7 45 5	+2·5	−24 36·5	−8·9	3·4	Good orange.	—
210	−Velorum - -	7 53 32	+1·7	−49 42·9	−9·5	8	"Brick red inclining to orange."	194
211	−Carinæ - -	7 56 42	+1·0	−60 34·9	−9·7	8	"Orange." In neb. h 3111: "Near it a ruddy star" (J. Herschel).	195
212	2704 B.A.C. Lyncis -	8 1 52	+5·0	+58 33·0	−10·2	6	Orange - -	196
213	ρ Argûs - -	8 3 17	+2·6	−24 1·0	−10·3	2·9	Reddish (Robinson).	—

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		h m s	s	° ′	″			
214*	β Cancri	8 11 5	+3·2	+ 9 29·6	−10·9	3·8	Reddish orange. "Pale orange" (Davis). "Reddish yellow" (Robinson). "Deep yellow" (Whitley).	—
215	16320 Lal. Hydræ	8 14 53	+3·1	+ 3 4·8	−11·1	8½	Very red. "Vividly red" (Bellamy).	—
216	2820 B.A.C. Puppis	8 19 35	+2·2	−37 57·9	−11·4	6	"De Color rojizo" (Moesta).	201
217	ε Argûs	8 20 28	+1·2	−59 11·2	−11·5	21	"Yellow: orange" (Tupman).	—
218	72 P. VIII. Puppis	8 20 44	+2·6	−23 43·3	−11·5	5½	"Orange" (Tupman).	—
219	17091 Lal. Hydræ	8 34 10	+2·7	−19 23·1	−12·4	6½	Reddish	205
220	3449 Lac. Mali	8 35 30	+2·5	−28 45·7	−12·5	7	Orange.	—
221	δ Cancri	8 39 0	+3·4	+18 31·3	−13·0	4·3	Orange. "Reddish" (Robinson).	—
222	Arg. 8952 Mali	8 41 17	+2·5	−27 50·3	−13·0	8½	Red	206
223	−Puppis	8 46 34	+2·0	−47 59·6	+13·3	8½	"Ruby coloured" (J. Herschel).	208
224	17497 Lal. Cancri	8 47 38	+3·4	+19 42·0	−13·3	8½	Red	209
225	3029 B.A.C. Cancri	8 49 45	+3·4	+17 36·7	−13·4	7	Pale crimson	211
226	17624 Lal. Cancri	8 49 50	+2·9	−10 59·8	−13·5	7½	Pale red. A blue star with a companion follows.	213
227	60 Cancri	8 50 28	+3·3	+12 1·2	−13·5	6–8	Reddish orange," Probably var."	212
228	σ^1 Ursæ Majoris	8 59 38	+5·3	+67 16·5	−14·1	4·8	Deep orange. "Decided orange" (Davis).	—
229	ω Hydræ	9 0 44	+3·2	+ 5 29·5	−14·2	5·6	Deep orange. "Pale orange" (Davis).	—
230	3121 B.A.C. Mali (κ Pyxis).	9 2 34	+2·6	−25 27·3	−14·3	4·8	Red	217
231	λ Argûs	9 4 19	+2·2	−43 1·6	−14·4	2·5	"Orange" (Tupman). "Blood red" (Pope).	—
231	Arg.+31: 1946 Cancri	9 4 35	+3·6	+31 22·3	−14·3	6½	Fiery red. ? Var.	218
232	π^2 Cancri	9 9 43	+3·3	+15 21·5	−14·8	5½	"Pale orange" (Chambers; Davis). The *p* star of a curious group of four.	219
233	*g* Carinæ	9 13 23	+1·7	−57 7·4	−15·0	4·5	"Deep orange red" (Tupman).	—
234	α (40) Lyncis	9 14 58	+3·7	+34 48·9	−15·0	3·4	Reddish orange. "Decided orange" (Davis). A small blue star 12^s *nf*.	220
235	Arg.+0: 2499 Hydræ	9 15 29	+3·1	+ 0 35·7	−15·1	7	Reddish	221
236	α Hydræ	9 22 40	+2·9	− 8 13·5	−15·4	2·0	"Reddish yellow" (Chambers; Robinson). "White in 1889" (Whitley). "Decided orange" (Davis). Possibly var.	223

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		h m s	s	° ″	″			
237	18688 Lalande Hydræ	9 24 36	+2·8	−20 18·4	−15·4	6	Fiery red. "Red" (Bellamy).	—
238	λ Leonis - - -	9 26 1	+3·4	+23 24·6	−15·6	4·4	Reddish orange. "Decided orange" (Davis). "Yellow" (Whitley). "Slightly red" (*Uran. Oxon.*).	224
239	N Velorum - -	9 28 11	+1·8	−56 35·6	−15·8	3·2	"Very rich yellow" (Tupman).	—
240	R Carinæ - -	9 29 44	+1·5	−62 20·7	−15·9	8	"Sanguine red" (J. Herschel). Var.	225
241	— Ursæ Majoris -	9 31 11	+5·0	+67 43·4	−15·9	7	Orange. ? Var. in colour.	—
242	ι Hydræ - -	9 34 45	+3·1	− 0 41·3	+16·1	4·2	"Orange" (Chambers; Robinson). "Pale orange" (Davis).	226
243	ε Leonis - - -	9 40 10	+3·4	+24 14·1	−16·4	3·1	"Pale orange" (Chambers, Davis). "Reddish yellow" (Robinson). "Yellow" (Whitley).	—
244	R Leonis - -	9 42 11	+3·3	+11 53·6	−16·5	Var. 5–10	Pale crimson. "Reddish" (Davis). "Fiery red" (Whitley).	228
245	ζ Carinæ - -	9 42 30	+1·6	−62 2·8	−16·5	3½	"Yellow; orange" (Tupman). Var.	—
246*	Ö-A(2) 10163 Hydræ	9 46 28	+2·8	−22 33·0	−16·7	7	Good red. "Distinctly red" (Bellamy).	229
247	μ Leonis - -	9 47 4	+3·4	+26 28·7	−16·8	4	Pale orange. "Yellow" (Robinson).	—
248	2412 Rad. Ursæ Majoris.	9 49 41	+4·1	+54 43·2	−16·9	7	Dark orange.	—
249	— Velorum - -	9 50 21	+2·5	−41 6·7	−17·2	7½	"Scarlet" (J. Herschel).	230
250	π Leonis - -	9 54 55	+3·1	+ 8 31·5	−17·1	5·0	Reddish orange. "Pale orange" (Davis). "Orange red" (Robinson). "Yellow" (Whitley).	231
251	19580 Lal. Sextantis -	9 55 55	+3·0	− 2 42·5	−17·1	7	Reddish. "Doubtful, if red" (Robinson).	—
252	19620 Lal. Hydræ -	9 57 6	+2·7	−23 19·5	−17·2	7	Reddish. "Slightly reddish" (Bellamy).	—
253	5436 Stone Carinæ -	9 57 53	+1·9	−59 48·7	−17·2	8½	"Scarlet" (J. Herschel).	232
254	19637 Lal. Sextantis -	9 57 55	+3·0	− 5 8·1	+17·2	7	Reddish. "Reddish yellow" (Robinson).	—
255	A (31) Leonis -	10 2 35	+3·2	+10 29·3	−17·5	4·6	Orange. "Decided orange" (Davis). "Orange yellow" (Whitley).	233
256	18 Sextantis - -	10 5 58	+3·0	− 7 55·5	−17·6	5½	Reddish orange. "Pale orange" (Davis). "Orange" (Robinson). ? Var.	234

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257	5536 Stone Antliæ -	10 7 30	+2·6	−34 49·8	−17·7	7	"Scarlet" (J. Herschel).	235
258	— Carinæ - -	10 11 2	+2·0	−60 11·5	−17·8	9	"Ruby red" - -	236
259	Arg.+42: 2108 Ursæ Majoris.	10 11 23	+3·6	+42 18·0	−17·8	6½	Fiery orange. "? Var."	—
260	q Carinæ - -	10 13 44	+2·0	−60 50·0	−17·9	3·3	"Orange red" (Tupman).	—
261	V Velorum - -	10 15 51	+2·2	−54 31·6	−17·9	3·4	"Red" (Tupman). "? Var."	
262	μ Ursæ Majoris -	10 16 22	+3·6	+42 0·1	−18·0	3·1	Orange. "Decided orange" (Davis). "Yellow" (Whitley).	238
263	μ Hydræ - -	10 21 15	+2·9	−16 19·5	−18·2	4·1	Reddish orange. "Decided orange" (Davis).	239
264	s Carinæ - -	10 24 12	+2·2	−58 13·7	−18·3	4·6	"Yellow; Orange" (Tupman).	—
265	4367 Lac. Carinæ -	10 28 42	+1·4	−72 42·4	−18·4	5·6	"Deep orange" (Tupman).	—
266	3630 B.A.C. Antliæ -	10 30 47	+2·7	−39 2·7	−18·4	6½	"Orange; almost scarlet" (J. Herschel).	240
267	r Carinæ - -	10 31 45	+2·3	−57 2·4	−18·4	5·3	"Orange red" (Tupman).	241
268**	3637 B.A.C. Hydræ -	10 32 36	+3·0	−12 51·8	−18·5	5·4	Fiery red. "Pale orange" (Davis). "Var., beyond question" (Gould). "Very conspicuously coloured" (Robinson).	242
269	ϑ^2 Carinæ - -	10 34 56	+2·3	−58 39·7	−18·6	5·2	"Deep orange red" (Tupman).	—
270	Arg. + 68: 617 Ursæ Majoris.	10 38 8	+4·2	+67 56·2	−18·7	6	Good pale red.	—
271	4435 Lac. Carinæ -	10 38 48	+2·3	−58 41·5	−18·7	6	"Red" (Brisbane).	—
272	w (4446) Lac. Carinæ	10 39 44	+2·3	−60 2·5	−18·8	6	"Red" (Brisbane). "Deep orange red" (Tupman).	245
273	η Argûs - -	10 41 10	+2·3	−59 9·5	−18·9	Var	"Orange" (Tupman)	247
274	μ Argûs - -	10 42 28	+2·6	−48 53·5	−18·9	2·9	"Very red" (Tupman).	—
275	20891 Lal. Sextantis -	10 45 0	+3·0	− 2 33·7	−19·0	6½	Pale orange. "Orange" (Robinson). "Very red" (Robinson).	—
276	20918 Lal. Hydræ -	10 46 45	+2·9	−20 43·2	−19·0	7	Crimson. "Very red" (Robinson).	248
277	u Carinæ - -	10 49 25	+2·4	−58 19·3	−19·0	4·1	"Bright orange red" (Tupman).	—
278	Arg. + 23: 2279 Leonis.	10 50 44	+3·2	+22 53·1	−19·0	7	Orange.	—
279	α Crateris - -	10 54 54	+2·9	−17 46·0	−19·2	4·1	Orange. "Pale orange" (Davis). "Red" (Robinson).	—

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
280	R Crateris - -	10 55 40	+3·0	−17 47·2	−19·2	Var. 8–9	Orange. In the field with α Crateris.	250
281	ψ Ursæ Majoris -	11 4 2	+3·4	+45 2·5	−19·4	3·1	Reddish. "Pale orange" (Davis). "Yellow" (Whitley).	254
282	x Carinæ - -	11 4 19	+2·5	−58 26·0	−19·4	4·6	"Deep orange red" (Tupman).	—
283	— Chamæleontis -	11 5 40	+1·0	−81 14·1	−19·5	8	"Ruby" (J. Herschel)	255
284	72 Leonis - -	11 9 53	+3·2	+23 38·4	−19·5	4·9	Reddish yellow, "Decided orange," "orange yellow" (Whitley).	256
285**	ν Ursæ Majoris - -	11 13 4	+3·2	+33 38·4	−19·5	3·8	Deep golden yellow. "Pale orange" (Davis).	—
286	ζ Crateris - -	11 14 20	+3·0	−14 14·2	−19·4	3·9	Reddish yellow. "Pale orange" (Davis). "Orange red" (Robinson).	—
287	87 Leonis - -	11 25 12	+3·1	− 2 27·1	−19·8	5·0	Orange (Chambers, Whitley). "Decided orange or reddish" (Davis).	261
288	λ Draconis - -	11 25 28	+3·6	+69 53·0	−19·8	4·1	Orange. "Decided orange" (Davis).	262
289	ν Leonis - -	11 31 50	+3·0	− 0 16·3	−19·8	4·5	Reddish yellow. "Pale orange" (Davis). "Red" (Wickham). "Orange yellow" (Whitley).	—
290	ω Virginis - -	11 33 18	+3·1	+ 8 41·3	−19·9	5·5	"Pale orange" (Chambers, Davis). "Red" (*Uran. Arg.*).	—
291	22104 Lal. Crateris -	11 34 46	+3·0	−16 4·0	−19·9	6	Red. "Reddish" (Robinson).	—
292	— Muscæ - -	11 35 0	+2·6	−72 0·3	−19·9	8½	"Fine ruby" (J. Herschel).	264
293	22122 Lal. Leonis -	11 35 59	+3·1	+25 21·6	−19·9	8	Reddish yellow -	
294	32 Ursæ Majoris -	11 39 9	+3·2	+49 4·3	−19·9	8	Red.	—
295	χ Ursæ Majoris -	11 40 46	+3·2	+48 20·0	−19·9	3·9	Golden. "Decided orange" (Davis). "Yellow" (Whitley).	266
296	3993 B.A.C. Muscæ -	11 43 25	+2·8	−66 15·5	−20·0	5·3	"Red" (Tupman).	—
297	— Centauri - -	11 45 7	+2·9	−56 29·4	−20·0	8	"Orange," about 10′ N. of neb. h 3365 (J. Herschel).	268
298	203 P. XI. Virginis -	11 53 6	+3·0	+ 4 2·3	−20·0	8	Red. ? mag. too small. 206 P. Mag. 5½ follows by 1 m. 43 s. and 10½′ N.	269
299	1845 Groom. Ursæ Maj.	11 55 47	+4·0	+81 24·7	−20·0	6	Reddish - -	270
300	5032 Lac. Crucis -	12 3 10	+3·0	−60 17·4	−20·0	6	"Red" (Stone).	—
301	ε Corvi - -	12 4 58	+3·0	−22 3·8	−20·0	3·1	Reddish orange. "Reddish" (Robinson). "Deep orange yellow" (Whitley). ? Var.	272

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
302	ε Muscæ - -	12 12 10	+3·2	−67 24·2	−20·0	4·7	"Orange red" (Tupman).	—
303	ε Crucis - - -	12 15 32	+3·2	−59 50·9	−20·0	4.0	"Orange" (Tupman).	—
304**	— Virginis - -	12 20 6	+3·0	+ 1 19·4	−20·0	8½	Good crimson. ? Var.	277
305	71 Ursæ Majoris -	12 20 17	+2·9	+57 16·6	−20·0	5½	Good orange. "Pale Orange" (Davis).	—
306	γ Comæ Berenicis -	12 21 57	+3·0	+28 49·5	−20·0	4·7	Deep golden yellow. "Pale orange" (Davis).	279
307	— Virginis - -	12 25 14	+3·0	+ 4 58·2	−19·9	8½	Deep red - -	281
308	γ Crucis - -	12 25 37	+3·3	−56 33·2	−19·9	2·0	"Clear orange yellow" (Gould).	282
309	4 Draconis - -	12 25 44	+2·7	+69 55·3	−19·9	5·3	Reddish orange. "Pale orange" (Davis).	—
310	23649 Lal. Virginis -	12 34 21	+3·1	− 5 33·1	−19·8	6½	"Reddish" (Chambers, Wickham).	—
311*	4287 B.A.C. Canum Venaticorum.	12 40 25	+2·8	+45 59·2	−19·8	5½	Red. "Good orange" (Brodie). "Deep orange" (Backhouse). "Decided red" (Davis). Probably var.	290
312	— Crucis - -	12 41 34	+3·5	−59 8·9	−19·8	8½	"Most intense blood red" (J. Herschel).	291
313	κ Crucis - - -	12 47 50	+3·5	−59 49·9	−19·6	7	In neb. h 3435; central and largest red star."	295
314	ψ Virginis - -	12 49 9	+3·1	− 8 59·7	−19·6	5·0	Reddish orange. "Decided orange" (Davis). "Red" (*Uran. Arg.*). "Orange" (Whitley).	—
315	— Draconis - -	12 52 30	+2·4	+66 32·1	−19·5	7	Pale crimson - -	298
316	24148 Lal. Comæ Berenicis.	12 53 10	+3·0	+18 18·5	−19·5	8	Red - - -	299
317	36 Comæ Berenicis -	12 53 59	+2·9	+17 56·8	−19·5	5·0	Reddish yellow. "Pale orange" (Davis). "Perhaps var."	300
318	5460 Lac. Centauri -	13 10 43	+3·4	−44 10·5	−19·1	7	"Red" (Stone).	—
319	5460 Lac. Centauri -	13 10 43	+3·4	−44 10·5	−19·1	7	"Red" (Stone).	—
320	γ Hydræ - -	13 13 28	+3·2	−22 38·6	−19·0	3·4	"Pale orange" (Chambers, Davis). "Red" (Brodie). "Perhaps var."	303
321	*i* Virginis - -	13 21 27	+3·2	−12 11·2	−18·8	5·5	Reddish. "Yellowish red" (Brodie). "Decided orange" (Davis). "Orange" (Whitley).	306
322	l^2 (74) Virginis -	13 26 45	+3·1	− 5 44·4	−18·6	4·9	Orange. "Reddish" (Davis). "Red" (*Uran. Arg.*)	309
323	W.B. XIII. 596 Comæ Berenicis.	13 32 16	+2·8	+25 10·2	−18·4	6½	Orange - - -	311
324	25213 Lal. Virginis -	13 34 35	+3·2	−15 56·3	−18·3	6½	Reddish. "Red" (Robinson).	—

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
325	83 Ursæ Majoris -	13 36 58	+2·3	+55 10·4	−18·3	4·8	Golden. "Decided orange" (Davis). "? Var."	312
326	7561 Stone Hydræ -	13 43 22	+3·4	−27 52·0	−18·6	6½	Very red. Double. 413 β. Mags. 7, 10 Pos. 109°, dist. 77″.	313
327	υ Boötis - -	13 44 39	+2·9	+16 17·6	−18·0	4·1	Orange (Chambers, Whitley.) "Pale orange (Davis). "Probably var."	314
328	25462 Lal. Virginis -	13 44 44	+3·3	−20 22·3	−18·0	7	"Reddish" (Chambers, Robinson).	—
329	3105 Rad. Canum Venat.	13 49 3	+2·5	+40 49·9	−17·8	7	Orange - -	316
330	π Hydræ - -	14 0 40	+3·4	−26 12·0	−17·3	3·5	Deep orange - -	318
331	θ Centauri - -	14 0 47	+3·6	−35 52·7	−17·3	1·7	"Pale orange?" (Tupman).	—
332	— Centauri - -	14 2 1	+4·2	−59 14·9	−17·2	8	"Double; both stars brick red" (J. Herschel).	319
333	13 Boötis - -	14 4 32	+2·2	+49 55·8	−17·1	5·5	Orange. "Decided orange" (Davis).	320
334	4700 B.A.C. Virginis -	14 5 22	+3·3	−15 49·8	−17·1	5·2	Good orange. "Decided orange" (Davis).	321
335	κ Virginis - -	14 7 34	+3·2	− 9 48·5	−16·9	4·3	Orange. "Decided orange" (Davis). "Orange red" (Robinson). "Orange yellow" (Whitley).	322
336	4 Ursæ Majoris -	14 9 14	−0·3	+78 1·0	−16·9	4·9	Orange. "Decided orange" (Davis).	324
337	R Centauri - -	14 9 22	+4·3	−59 26·8	−16·9	Var. 6–10	"Ruby or high orange" (J. Herschel).	323
338	4732 B.A.C. Ursæ Minoris.	14 10 11	+1·1	+69 54·1	−16·9	5·3	"Pale orange" (Chambers, Davis).	325
339**	α Boötis - -	14 11 6	+2·8	+19 42·2	−16·8	0·0	Golden yellow. "Pale orange" (Davis). "Deep yellow" (Whitley).	326
340	Arg. +30 : 2513 Boötis	14 17 47	+2·6	+29 50·4	−16·6	6½	Reddish.	
341	4775 B.A.C. Boötis -	14 19 11	+2·9	+ 8 32·5	−16·5	7	Deep orange. "? Colour var."	327
342*	Arg. +26 : 2563 Boötis	14 19 41	+2·7	+26 9·5	−16·5	8	Ruby red. "? Var" -	328
343	106 Virginis - -	14 23 25	+3·2	− 6 27·0	+16·3	6	Red.	—
344*	ρ Boötis - -	14 27 31	+2·6	+30 48·6	−16·1	3·6	Orange. "Pale orange" (Davis). "Deep orange yellow" (Whitley).	330
345	5 Ursæ Minoris -	14 27 43	−0·1	+76 8·4	−16·0	4·3	Deep yellow (Chambers, Whitley). "Decided orange" (Davis).	332
346	α^2 Centauri - -	14 32 49	+4·5	−60 25·2	−15·7	1·0	"Red." "Rich yellow."	335

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
347	Arg.+33:2482 Boötis	14 35 4	+2·5	+32 57·9	−15·6	8½	Decided red.	—
348	34 Boötis	14 38 1	+2·6	+26 57·2	−15·5	4·9	Orange. "Decided orange or reddish" (Davis). "Orange yellow" (Whitley).	337
349**	ε Boötis	14 40 37	+2·6	+27 29·7	−15·2	2·6	Golden yellow. "Pale orange" (Davis). "Yellowish orange" (Backhouse). "Yellow" (Whitley).	339
350	σ Libræ	14 44 25	+3·5	−27 32·5	−15·0	5	Red	340
351	β Ursæ Minoris	14 50 59	−0·2	+74 33·8	−14·7	2·1	Deep golden yellow. "Decided orange" (Davis). "Yellow" (Whitley). "? Var."	341
352	27215 Lal. Libræ	14 52 19	+3·3	−12 2·6	−14·6	7½	Red.	—
353	4949 B.A.C. Ursæ Minoris.	14 55 59	−0·9	+66 19·8	−14·3	4½	"Orange" (Chambers, Backhouse). "Reddish" (Davis).	342
354	20 Libræ	14 58 12	+3·5	−24 53·3	−14·3	3·2	Orange red. "Reddish" (Bellamy). "Red" (Robinson). "Not red" (*Washburn Obs.*) "White" (Whitley).	343
355	ν^1 Libræ	15 1 3	+3·3	−15 52·8	−14·1	5·4	Reddish orange. "Decided orange," (Davis). "Orange" (Whitley).	344
356	4984 B.A.C. Libræ	15 4 1	+3·5	−23 36·2	−14·0	7½	Red.	—
357	4976 B.A.C. Triang. Aust.	15 4 40	+5·6	−69 42·2	−14·1	6	"Almost scariet" (J. Herschel.) "Red" (Stone).	345
358	δ Lupi	15 11 45	+3·6	−29 46·8	−13·5	3·7	Red	346
359	ϕ^1 Lupi	15 15 28	+3·8	−35 53·9	−13·2	3·6	"Very red" (Gould). "Reddish yellow" (Williams).	—
360	— Apodis	15 16 8	+7·0	−75 34·5	−13·2	7	"Very high red" (J. Herschel).	347
361	11 Ursæ Minoris	15 17 11	−0·08	72 11·2	−13·0	5·1	Reddish. "Decided orange" (Davis).	351
362	ε Trianguli Australis	15 27 33	+5·4	−65 58·6	−12·5	4·6	"Orange" (Tupman).	—
362	39 Libræ	15 30 56	+3·6	−27 45·2	−12·1	3·9	Decided red. "Not red" (*Washburn Obs*).	355
363	Arg.+24:2901 Coronæ Borealis.	15 33 58	+2·6	+24 51·0	−11·9	7	Orange. "Orange ruby" (Webb).	—
364*	θ Ursæ Minoris	15 34 22	−1·9	+77 40·9	−11·8	5·3	Orange. "Decided orange" (Davis).	357
365	κ Libræ	15 36 11	+3·4	−19 21·3	−11·7	5·0	Reddish orange. "Decided orange" (Davis). "Orange yellow" (Whitley).	—
366	κ Serpentis	15 44 14	+2·7	+18 27·0	−11·3	4·2	Orange "Decided orange" (Davis). "Orange yellow" (Whitley).	358

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		h m s	s	° ′	″			
367	−Coronæ Borealis -	15 45 56	+2·1	+39 52·3	−11·1	8½	Good red. "Fine ruby" (J. Herschel). Var.	361
368*	ρ Serpentis - -	15 46 51	+2·6	+21 16·8	−11·1	4·8	Pale orange. "Decided orange, but less so than κ" (Davis). "Deep yellow" (Whitley).	363
369	θ Libræ - -	15 48 7	+3·4	−16 26·2	−10·9	4·3	"Pale orange" (Chambers, Davis). "Yellow" (Whitley).	365
370	28997 Lal. Libræ -	15 51 25	+3·4	−15 44·5	−10·7	6½	Red. "Reddish" (Robinson).	—
371	Arg. +47: 2291 Coronæ Borealis.	15 59 43	+1·8	+47 30·6	−10·1	7	Reddish orange -	367
372	6661 Lac. Normæ -	16 0 28	+4·6	−52 48·6	−10·1	6½	"Red" (Stone).	—
373	5347 B.A.C. Scorpii -	16 2 1	+3·6	−26 3·5	− 9·9	5½	Good red.	—
374	W.B. XV., 1569 Herculis.	16 3 2	+2·6	+22 5·5	− 9·9	—	Reddish yellow. "Straw colour" (*Washburn Obs.*). "Pale yellowish red" (Brodie).	369
375	47 Serpentis - -	16 3 39	+2·9	+ 8 48·6	− 9·7	5½	Decidedly reddish." "Pale orange" (Davis).	370
376	Arg. + 9: 3153 Serpentis.	16 3 48	+2·9	+ 8 53·6	− 9·7	7½	Orange - - -	371
377**	δ Ophiuchi - -	16 9 6	+3·1	− 3 26·2	− 9·4	2·8	Reddish orange. "Decided orange" (Davis). "Very red (Wickham). "Orange red" (Robinson). "Deep orange yellow" (Whitley).	373
378	−Normæ - -	16 10 49	+4·3	−45 33·3	− 9·2	8½	"Ruby red" (J. Herschel).	374
379	ν^1 Coronæ Borealis -	16 18 35	+2·2	+34 1·1	− 8·6	5·1	Orange. "Decided orange" (Davis). "Deep orange yellow" (Whitley).	376
380**	ν^2 Coronæ Borealis -	16 18 43	+2·2	+33 55·2	− 8·6	5·0	Orange. "Decided orange" (Davis). "Deep orange yellow" (Whitley). This and the preceding star are almost identical in colour and size.	377
381	V Ophiuchi - -	16 21 10	+3·3	−12 12·0	− 8·5	Var 8–9	"Red or crimson" (Brodie). Dunér's var. "Very red" (Robinson).	379
382	α Scorpii - -	16 23 16	+3·7	−26 12·6	− 8·2	1·1	Fiery red - -	381
383	β Herculis - -	16 25 55	+2·6	+21 42·5	− 8·0	2·8	Golden. "Pale orange" (Davis). "Yellow" (Whitley). There is a red star 4″ *nf.* mag. 7 ?	383
384	30129 Lal. Herculis -	16 27 22	+2·2	+35 26·3	− 7·9	6½	Reddish orange.	—

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		h m s	s	° ′	″			
385	111 P. XVI. Scorpii -	16 29 47	+3·9	−35 3·0	+ 7·7	4·4	"Red" - -	384
386	— Ophiuchi - -	16 33 39	+3·3	−11 7·5	− 7·4	8	Red.	—
387	— Scorpii - -	16 34 12	+3·8	−32 11·0	− 7·4	8	"Deep red, like a drop of blood" (J. Herschel).	385
388	α Trianguli Australis	16 38 4	+6·3	−68 50·6	− 7·0	2·2	"Orange; yellow" (Tupman).	—
389	Arg.+32: 2772 Herculis.	16 39 33	+2·1	+36 42·2	− 6·9	8	Reddish. In the field with clus. 13 M.	386
390	η Aræ - -	16 41 8	+5·4	−58 51·7	− 6·9	3·8	"Orange" (Tupman).	—
391	ε Scorpii - -	16 43 41	+3·9	−34 6·7	− 6·5	2·2	"Orange; yellow" (Tupman).	—
392	W.B. XVI. 1347 Herculis.	16 44 8	+1·9	+42 25·7	− 6·5	7	Pale orange - -	389
393	ζ^2 Scorpii - -	16 47 32	+4·2	−42 11·3	− 6·3	3·6	"Deep orange-yellow" (Williams).	—
394	ζ Aræ - -	16 50 20	+4·9	−55 49·9	− 6·0	3·2	"Bright orange" (Tupman).	—
395	30 Ophiuchi - -	16 55 47	+3·2	− 4 4·3	− 5·5	5·0	Reddish orange. "Decided orange" (Davis). "Probably var."	399
396**	α^1 Herculis - -	17 10 5	+2·7	+14 30·2	− 4·3	3·2	"Deep orange" (Chambers, Backhouse). "Decided orange" (Davis). "Orange - yellow" (Whitley). "Reddish; companion blue" (Robinson). "Var."	402
397**	4490 Rad. (1890) Ophiuchi.	17 10 33	+3·4	−15 6·7	− 4·3	7½	Fiery red.	—
398	π Herculis - -	17 11 33	+2·1	+36 55·3	− 4·2	3·4	Fiery orange. "Decided orange" (Davis.) "Deep yellow" (Whitley). "? Var."	404
399	—Ophiuchi - -	17 14 43	+3·0	+ 2 15·7	− 4·0	7	Red - - -	407
400	Arg.+17: 3225 Herculis.	17 16 19	+2·6	+17 8·4	− 3·9	8	Red.	—
401	β Aræ - -	17 16 59	+5·0	−55 26·1	− 3·7	2·8	"Deep bright orange" (Tupman).	—
402	43 Ophiuchi - -	17 17 4	+3·7	−28 2·7	− 3·7	5½	Reddish - -	408
403	δ Aræ - -	17 22 4	+5·4	−60 36·0	− 3·4	3·7	"Pale orange" (Tupman).	—
403A	—Scorpii - -	17 23 31	+4·0	−35 33·8	− 3·3	9	"Very deep red" (J. Herschel).	409
404**	— Ophiuchi - -	17 23 48	+3·5	−19 23·5	− 3·2	8	Very decided red. "Ruby" (J. Herschel). "Deep red nearly crimson" (Brodie).	410
405	— Scorpii - -	17 33 24	+4·2	−41 34·5	− 2·5	8	"Ruby" (J. Herschel).	414

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		h m s	s	° ′ ″	″			
406	— Arræ - - -	17 34 40	+5·2	−57 40·4	− 2·4	8	"Scarlet or high orange" (J. Herschel).	415
407	μ Herculis - -	17 42 33	+2·3	+27 46·7	− 2·3	3·5	"Orange red" (Robinson).	—
408	76 Espin Herculis -	17 43 19	+2·1	+36 7·2	− 1·7	6½	Reddish orange.	—
409	Arg. + 36: 2942 Herculis.	17 44 24	+2·0	+36 35·4	− 1·3	6½	Reddish orange.	—
410	W.B. XVII. 877 Ophiuchi.	17 46 4	+2·8	+11 58·6	− 1·3	6½	Pale orange.	—
411	Arg. + 1: 3524 Ophiuchi.	17 46 57	+3·0	+ 1 7·9	− 1·2	7	Red. ? 886 Weisse.	—
412	Arg. + 1: 3528 Ophiuchi.	17 47 27	+3·0	+ 1 20·2	− 1·0	6½	Fiery red. In a fine field.	—
413	— Ophiuchi - -	17 53 2	+3·0	+ 2 43·8	− 0·7	7	Reddish. "? Var" -	422
414**	γ Draconis - -	17 54 17	+1·4	+51 30·0	− 0·5	2·4	Fiery orange. "Decided orange" (Davis).	423
415	γ^2 Sagittarii - -	17 59 23	+3·8	−30 25·4	− 0·1	3·0	Reddish orange. "? Var."	425
416	— Sagittarii - -	18 3 58	+3·4	−15 18·1	+ 0·2	8	Red. "? Var." - -	427
417	7634 Lac. Sagittarii -	18 8 40	+3·8	−29 51·1	+ 0·6	7½	"Reddish" (*Washburn Obs.*).	—
418	— Sagittarii - -	18 9 11	+3·5	−18 56·8	+ 0·8	8	Fiery red. ? Mag. ? Var.	—
419	33627 Lal. Sagittarii -	18 12 30	+3·5	−18 30·6	+ 1·0	8	Reddish.	—
420	Arg. + 17: 3520 Herculis.	18 13 21	+2·6	+17 55·3	+ 1·2	7	Red.	—
421	Arg. + 23: 3299 Herculis.	18 13 57	+2·5	+23 14·5	+ 1·2	7	Orange - - -	433
422	δ Sagittarii - -	18 14 35	+3·8	−29 52·2	+ 1·3	2·8	Orange red - -	434
423	21 Sagittarii - -	18 19 23	+3·6	−20 35·7	+ 1·6	4·9	Red. "Decided orange" (Davis).	439
424	109 Herculis - -	18 19 26	+2·5	+21 43·5	+ 1·7	3·9	Golden yellow. "Decided orange or reddish" (Davis).	440
425	λ Sagittarii - -	18 21 48	+3·7	−25 28·6	− 1·9	3·1	Orange - - -	441
426**	6306 B.A.C. Sagittarii	18 27 1	+3·4	−14 56·3	− 2·3	6½	Fiery red. "Reddish" (Bellamy). "Golden yellow" (Brodie). "Reddish" (Davis).	446
427**	Arg. + 36: 3168 Lyræ	18 28 53	+2·1	+36 54·2	+ 2·5	8	Decided crimson. ? Var.	448
428	1 Aquilæ - - -	18 29 45	+3·3	− 8 18·8	+ 2·6	4	Orange. "Decided orange" (Davis).	449
429	Arg. + 38: 3219 Lyræ	18 30 46	+2·0	+38 21·7	+ 2·6	7	Red.	—
430	6343 B.A.C. Herculis	18 31 21	+2·5	+23 31·5	+ 2·6	5½	Orange. "Decided orange" (Davis).	452
431	34746 Lal. Aquilæ -	18 39 16	+3·2	− 6 38·2	+ 3·4	7	Reddish - - -	457

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		h m s	s	° ″	″			
432	Arg.+36: 3243 Lyræ	18 39 23	+2·1	+36 52·0	+ 3·4	8	Fiery red. "No really red star here" (*Washburn Obs.*) ? Var.	458
433	Arg.+39: 3505 Lyræ	18 39 57	+2·0	+39 12·1	+ 3·4	7	Slightly red. Has a small companion. ? Colour var.	459
434	Arg.+18: 3817 Herculis.	18 42 18	+2·6	+18 35·7	+ 3·6	7	Reddish - - -	463
435**	— Clypei Sobieskii -	18 44 30	+3·3	− 8 1·2	+ 3·7	8	Rich fiery red. "Orange" (Brodie). "? Var."	464
436*	ν^1 Sagittarii - -	18 48 8	+3·6	−22 52·1	+ 4·1	5·2	Red - - - -	466
437	ν^2 Sagittarii - -	18 49 4	+3·6	−22 47·8	+ 4·2	5½	Pale orange - -	468
438	δ^2 Lyræ - - -	18 51 0	+2·1	+36 46·2	+ 4·4	4·5	Fiery orange. "Decided orange or reddish" (Davis). "Orange" (Whitley). Good field.	470
439	W.B. XVIII. 1528 Herculis.	18 51 41	+2·6	+17 59·1	+ 4·5	5½	Pale orange. "Decided orange" (Davis).	472
440	9 Aquilæ - -	18 51 42	+3·2	− 5 58·6	+ 4·4	5	Orange. "Pale orange" (Davis). "Red" (*Uran Arg.*).	—
441*	ξ^2 Sagittarii - -	18 51 45	+3·6	−21 14·3	+ 4·5	3·5	Orange - - -	471
442	Arg.+36: 3339 Lyræ	18 53 37	+2·1	+36 20·0	+ 4·6	7	Orange.	—
443	Arg.+38: 3362 Lyræ	18 53 43	+2·0	+38 39·9	+ 4·6	7½	Pale orange - -	476
444*	— Aquilæ - -	18 53 56	+2·7	+14 12·9	+ 4·6	9	Deep red. ? Mag. Probably var. G.F.C.	475
445	λ Lyræ - -	18 56 13	+2·3	+32 0·3	+ 4·7	5·1	Orange. "Decided orange" (Davis). "? Var."	479
446	12 Aquilæ - -	18 56 20	+3·2	− 5 52·8	+ 4·8	4·0	Orange. "Pale orange" (Davis). "? Var."	478
447	35562 Lal. Aquilæ -	18 57 33	+2·9	+ 8 15·6	+ 4·9	6½	Orange. ? Var. - -	480
448	35624 Lal. Aquilæ -	18 58 33	+2·9	+ 8 8·8	+ 5·0	8	Good orange. Var. both in colour and brightness.	482
449**	35611 Lal. Aquilæ -	18 59 3	+3·2	− 5 50·0	+ 5·0	7½	Very fine fiery red. "Deep red" (Wickham). "Crimson" (Bellamy). "? Var."	483
450	τ Sagittarii - -	19 0 41	+3·7	−27 49·0	+ 5·2	3·5	Reddish orange -	485
451	35928 Lal. Vulpeculæ	19 4 37	+2·5	+24 1·2	+ 5·5	7	Red - - -	487
452	Arg.+18: 4011 Sagittæ	19 11 8	+2·6	+18 20·9	+ 6·0	7	Orange - - -	490
453	8 Draconis - -	19 12 31	+0·01	+67 29·1	+ 6·0	3·2	"Decided orange" (Davis).	491
454	— Lyræ - -	19 15 3	+2·4	+27 4·6	+ 6·4	7	Red. "? Var" -	492
455	Arg.+22: 3660 Vulpeculæ.	19 15 16	+2·5	+22 23·1	+ 6·4	8	Reddish - -	493

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456	4 Vulpeculæ -	19 21 5	+2·6	+19 36·1	+ 6·8	5·2	Orange. "Decided orange." "Pale red" (Davis). Fine field. Two other orange stars near.	—
457*	Arg.+49: 2999 Cygni	19 21 55	+1·6	+50 2·2	+ 6·9	7	Fiery red.	—
458	Arg.+1: 4004 Aquilæ	19 22 48	+3·0	+ 1 58·4	+ 7·0	8	Reddish. "? Var" -	498
459**	6702 B.A.C. Draconis	19 25 8	−2·0	+76 21·6	+ 7·0	6½	Strong fiery red. "? Var."	502
460	Arg.+2: 3904 Aquilæ	19 25 10	+3·0	+ 2 42·8	+ 7·0	6½	Reddish orange.	499
461	36 (ε) Aquilæ -	19 25 24	+3·1	− 2 59·9	+ 7·2	5·2	Reddish orange. "Light orange" (Brodie). "Decided orange" (Davis).	500
462	Arg.+45: 2906 Cygni	19 25 50	+1·8	+45 50·4	+ 7·2	8	Pale crimson. "Very red; ? Var" (Espin).	—
463	Arg.+1: 4021 Aquilæ	19 26 0	+3·0	+ 1 48·6	+ 7·3	8	Orange - -	501
464**	β Cygni - -	19 26.41	+2·4	+27 45·0	+ 7·4	3·1	Yellow, with a blue companion, mag. 7, dis. 34″. "Orange" (Backhouse). "Deep yellow" (Whitley). "Decided orange" (Davis). "? Var."	503
465	Arg.+4: 4152 Aquilæ	19 28 12	+3·0	+ 4 49·0	+ 7·4	7	Reddish orange -	504
466	36981 Lal. Sagittarii	19 28 34	+3·4	−16 35·5	+ 7·4	7½	Crimson. "Red; deeper at times" (Bellamy). ? Var. in colour.	505
467	Arg.+5: 4190 Aquilæ	19 28 57	+2·9	+ 5 14·8	+ 7·6	7	Orange - -	506
468	Arg.+32: 3522 Cygni	19 37 7	+2·3	+32 23·2	+ 8·2	8	Red - - -	509
469	37504 Lal. Aquilæ -	19 39 35	+3·0	+ 4 44·3	+ 8·3	8	Reddish. "? Var." -	510
470	Arg.+12: 4060 Aquilæ	19 39 57	+2·8	+12 59·4	+ 8·3	7	Reddish. Most southerly of three stars in a row.	511
471*	Arg.+40: 3866 Cygni	19 40 36	+2·0	+40 28·0	+ 8·5	6	Fiery red - -	—
472	γ Aquilæ - -	19 41 30	+2·8	+10 22·2	+ 8·6	2·8	Brilliant orange. "Reddish yellow" (Robinson). "Decided orange" (Davis). "Deep yellow" (Whitley).	512
473	Arg.+22: 3812 Vulpeculæ.	19 43 53	+2·6	+22 31·2	+ 8·8	8	Red - - -	515
474	χ Cygni - -	19 46 44	+2·2	+32 39·7	+ 9·0	Var. 4-0	Fiery red when approaching maximum. "Orange" (Davis). "Yellowish white" (Whitley).	518

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		h m s	s	° ′	″			
475	19 Cygni - -	19 47 1	+2·1	+38 27·8	+ 9·0	5·5	Full orange. "Pale red" (Davis). "Deep orange" (Backhouse).	519
476	Arg.+43: 3425 Cygni	19 53 57	+1·9	+43 59·3	+ 9·5	8	Fiery red - -	521
477	13 Sagittæ - -	19 55 31	+2·7	+17 14·3	+ 9·6	7½	Orange. There is a red star of mag. 7½, *n.f.*	—
478	62 (*e*) Sagittarii -	19 56 30	+3·7	−27 59·3	+ 9·7	4·7	Reddish orange -	522
479	38428 Lal. Cygni -	20 0 3	+2·2	+38 2·8	+10·0	8	Reddish. ? Var.	—
480	— Sagittæ - -	20 0 41	+2·6	+20 22·3	+10·0	8½	"Blood red; not very red; red at times" (Robinson). "Very red" (Espin). "? Var. in colour" (Robinson).	527
481	Ö—Arg. (2) 20234 Sagittarii.	20 0 48	+3·7	−27 30·6	+10·0	7	Deep red. "Ruby" (J. Herschel). ? Mag. Gould made it 8, more than once.	526
481A	—Pavonis - -	20 2 29	+5·1	−60 13·5	+10·1	8½	"Very red" (J. Herschel).	528
482	Arg.+16: 4153 Sagittæ.	20 3 35	+2·7	+16 23·1	+10·2	6½	Orange - -	530
483	66 Aquilæ - -	20 8 4	+3·1	+ 1 18·5	+10·6	5½	Orange. "Decided orange" (Davis).	538
484*	Arg.+38: 3957 Cygni	20 9 46	+2·2	+38 25·5	+10·9	8	Decided red - -	541
485	o^1 (30) Cygni -	20 10 9	+1·9	+46 30·8	+10·8	3·8	Fine golden yellow, with a blue companion. "Pale red" (Davis). "Orange yellow" (Whitley).	543
486*	Ö—Arg. (2) 20363 Capricorni.	20 11 14	+3·5	−21 36·5	+10·8	7½	Decided red. "Perhaps the finest of my ruby stars" (J. Herschel). "Deep ruby; fine colour" (Brodie). "Bright ruby" (Bellamy).	545
487	23 Vulpeculæ -	20 11 37	+2·5	+27 30·4	+10·8	4·8	Full orange. "Decided orange" (Davis).	546
488	α^1 Capricorni - -	20 12 6	+3·3	−12 49·0	+10·9	4·5	Golden yellow. "Pale orange" (Davis). "Orange yellow" (Whitley).	547
489	32 Cygni - -	20 12 28	+1·9	+47 24·4	+10·9	4·1	Pale orange. "Reddish" (Davis). "Orange" (Whitley).	549
490	α^2 Capricorni -	20 12 30	+3·3	−12 51·3	+10·9	3·8	Golden yellow. "Pale orange" (Davis). "Orange yellow" (Whitley).	548
491	6986 B.A.C. Cygni -	20 13 21	+2·1	+40 3·1	+10·9	5·5	Reddish orange. "Pale red" (Davis).	551
492	σ Capricorni - -	20 14 2	+3·5	−19 25·8	+11·0	5·6	Double: A, pale orange; B, colourless or ruddy. Dist. 50″. "Decided orange" (Davis).	550

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493	U Cygni - -	20 16 30	+1·9	+47 34·7	+11·2	Var. 7–11	Very red. "Remarkable ruby." Var. In striking contrast with blue star near.	553
494	7027 B.A.C. Cygni -	20 19 12	+2·1	+40 42·4	+11·4	6	Reddish. "Pale red" (Davis).	555
495	— Aquilæ - -	20 19 42	+3·0	+ 0 13·7	+11·4	10	Reddish. ? Var. 8–10. Should be watched.	556
496	39 Cygni - -	20 19 52	+2·4	+31 52·0	+11·4	4·6	Orange. "Decided orange" (Davis).	557
497	39304 Lal. Delphini -	20 20 55	+2·9	+ 9 43·8	+11·5	7	Orange. "Probably var."	558
498	8451 Lac. Capricorni	20 21 50	+3·7	−28 35·5	+11·6	8	Decided red. "Fine ruby" (J. Herschel).	559
499	ω^1 Cygni - -	20 23 58	+1·8	+49 3·2	+11·8	5·6	Yellow. "Reddish" (Davis).	—
500*	Arg.+15: 4172 Delphini.	20 24 34	+2·8	+15 55·9	+11·8	8½	Good red. There is a blue star of mag. 8 to the S.	—
501	Arg+39: 4208 Cygni	20 25 13	+2·2	+39 38·8	+11·8	9	Fiery red. "Colour very fine" (Espin).	—
502*	ω^3 Cygni - -	20 28 15	+1·8	+48 52·9	+11·9	5·6	Deep golden yellow. "Pale orange" (Davis). "Orange" (Whitley).	562
503	47 Cygni - -	20 30 1	+2·3	+34 54·5	+12·1	4·8	Orange. "Reddish" (Davis).	563
504	70 Aquilæ - -	20 31 31	+3·1	− 2 53·8	+12·3	5·3	Golden yellow. "Reddish" (Davis).	564
505	Arg.+17: 4370 Delphini.	20 33 21	+2·7	+17 54·8	+12·4	7	Full orange - -	566
506	Arg.+17: 4401 Delphini.	20 40 53	+2·7	+17 43·6	+12·9	7	Reddish. "Probably var."	569
507	Arg.+45: 3271 Cygni	20 43 28	+2·0	+45 41·1	+13·1	8½	Pale ruby.	—
508	Arg.+50: 3209 Cygni	20 46 26	+1·8	+50 24·8	+13·3	7½	Red.	—
509	Arg.+49: 3386 Cygni	20 47 38	+1·8	+49 45·2	+13·3	7	Deep orange.	—
510	Arg.+32: 3980 Cygni	20 50 14	+2·4	+33 3·4	+13·4	5½	Orange. "Decided orange" (Davis).	572
511	32 Vulpeculæ -	20 50 18	+2·6	+27 41·6	+13·4	5	"Orange red" (Robinson).	—
512	1294 Bess. Delphini -	20 52 32	+2·8	+15 52·0	+13·6	8	Pale orange. "Probably var. both in mag. and colour."	573
513*	Arg.+45: 3349 Cygni	20 54 32	+2·1	+46 5·0	+13·8	8	Fiery red.	—
514	ζ Equulei - -	20 59 36	+3·0	+ 5 6·2	+14·1	5½	Red. "Decided orange or reddish" (Davis).	—
515	A Capricorni -	21 1 16	+3·5	−25 24·3	+14·1	4·6	Deep orange - -	575
516	ξ Cygni - -	21 1 17	+2·2	+43 31·6	+14·2	3·7	Deep golden yellow. "Decided orange or reddish" (Davis). "Deep orange yellow" (Whitley).	576

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517	Arg.−17: 6181 Capricorni.	21 1 41	+3·4	−16 49·5	+14·3	8½	Red.	—
518	61 P. XXI. Cephei -	21 10 13	+1·5	+59 41·0	+14·7	7½	Remarkable fiery red. "? Var."	579
519	8745 Lac. Indi -	21 15 14	+5·5	−70 9·6	+14·9	6	"Red inclining to orange" (J. Herschel).	580
520	Arg.+49: 3499 Cygni	21 15 21	+2·0	+49 38·8	+15·1	7	Fiery red.	—
521	33 Capricorni -	21 18 29	+3·4	−21 16·6	+15·1	5½	Pale orange. "Red" (Gore). "Decided orange or reddish" (Davis).	—
522*	− Cygni - -	21 18 39	+2·3	+41 58·1	+15·2	9	Deep red - -	582
523	Arg.+40: 4502 Cygni	21 19 27	+3·4	+40 31·6	+15·2	7½	Red.	—
524	2 Pegasi - -	21 25 25	+2·7	+23 12·0	+15·6	4·3	Bright orange. "Decided orange."	583
525	Arg.+45: 3584 Cygni	21 29 32	+2·2	+45 24·6	+15·8	7	Reddish orange -	585
526	Arg.+44: 3877 Cygni	21 32 16	+2·3	+44 55·7	+16·0	7	Reddish orange -	587
527	889 Bess. Cygni -	21 37 47	+2·5	+35 3·2	+16·3	7	Unmistakeable fiery red.	589
528	− Cygni - -	21 37 47	+2·4	+42 23·1	+16·3	7	Strong reddish tinge. "Schmidt's *Nova* of 1876. ? δ too little. ? Present mag.	590
529**	923 Bess. Cygni -	21 39 8	+2·5	+37 33·5	+16·3	8	Deep fiery red or pale crimson. 1"Good red" (Brodie).	592
530**	ε Pegasi - -	21 39 16	+2·9	+ 9 25·0	+16·4	2·4	Full orange. "Deep orange yellow" (Whitley). "Decided orange" (Davis). "Reddish yellow" (Robinson). "Probably var."	591
531**	μ Cephei - -	21 40 26	+1·8	+58 19·2	+16·4	Var. 4–6	Intense reddish orange. "Light orange" (Brodie). "Decided red" (Davis).	594
532**	42431 Lal. Aquarii -	21 41 20	+3·1	− 2 40·5	+16·4	6½	Decided red. "Red" (Robinson). "? Var."	596
533	Arg.+57: 2396 Cygni	21 43 3	+1·8	+57 37·1	+16·5	8	Reddish orange.	—
534	− Cygni - -	21 51 30	+2·2	+50 1·3	+16·9	9	Pale red - -	598
535*	7658 B.A.C. Cephei -	21 53 50	+1·7	+63 8·9	+17·0	5·2	Fiery orange. "Pale red, 3 obs." (Davis).	599
536	3637 Groom. Cephei -	21 54 37	+1·5	+65 40·7	+17·1	6½	Fiery red. Blue star, mag. 6½ near, *p*.	—
537	− Pegasi - -	21 59 26	+2·7	+27 51·8	+17·3	7½	Fiery red. "Orange tinge" (Brodie). ? Var.	600
538	α Aquarii - -	22 0 38	+3·1	−0 48·4	+17·3	3·2	"Orange" (Chambers, Robinson).	—
539	18 Cephei - -	22 0 53	+1·8	+62 38·0	+17·3	5·4	Reddish orange. "Decided orange" (Davis).	601

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540	20 Cephei - -	22 1 58	+1·8	+62 17·9	+17·3	5·4	Orange. "Decided orange" (Davis).	602
541	ζ Cephei - -	22 7 23	+2·0	+57 42·5	+17·7	3·5	Pale orange. "Decided orange" (Davis).	604
542	7766 B.A.C. Cephei -	22 9 15	+1·9	+62 47·8	+17·7	6·1	Reddish orange -	606
543	7765 B.A.C. Lacertæ -	22 9 36	+2·6	+39 13·1	+17·7	4·6	Orange. "Decided orange" (Davis).	607
544	1 Lacertæ - -	22 11 36	+2·6	+37 15·1	+17·8	4·1	Orange. "Pale orange" (Davis).	608
545	43501 Lal. Pegasi -	22 12 27	+3·0	+ 4 38·6	+17·8	7½	Dull pale red. "Tinge of red" (Brodie).	609
546	7813 B.A.C. Cephei -	22 19 20	+2·2	+55 27·4	+18·1	7	Good red - -	610
547	β Lacertæ - -	22 19 38	+2·3	+51 43·7	+18·1	4·5	Orange. "Pale orange" (Davis).	611
548	36 Pegasi - -	22 24 9	+3·0	+ 8 37·1	+18·3	6	Reddish orange. "Red" (*Uran. Arg.*).	—
549	5 Lacertæ - -	22 25 22	+2·5	+47 11·7	+18·3	4·6	Reddish orange. "Deep orange, but not reddish" (Davis).	612
550	δ Cephei - -	22 25 27	+2·2	+57 54·1	+18·3	Var 3½–4½	Orange, with blue companion in good contrast. "Pale orange" (Davis).	613
551	Arg. +56: 2793 Cephei	22 26 23	+2·3	+56 29·0	+18·4	8	Fiery red.	—
552	Arg. +57: 2562 Cephei	22 30 45	+2·3	+57 39·3	+18·5	7½	Fiery red.	—
553	Arg. +57: 2568 Cephei	22 32 39	+2·3	+57 54·6	+18·5	7½	Red. "Var. 7—8" (Espin).	—
554	Arg. +56: 2821 Cephei	22 34 42	+2·4	+56 16·7	+18·6	5½	Reddish. "Decided orange or Reddish" (Davis).	615
555	11 Lacertæ - -	22 36 7	+2·6	+43 46·2	+18·7	4·7	Reddish orange. "Decided orange" (Davis).	616
556	β Gruis - -	22 36 41	+3·6	+47 24·5	+18·7	2·2	Reddish - - -	617
557*	τ^2 Aquarii - -	22 44 17	+3·2	−14 7·2	+18·9	4·1	Orange. "Decided orange" (Davis) ? Var.	620
558	15 Lacertæ - -	22 47 30	+2·7	+42 46·8	+19·0	5·1	Reddish orange. "Decided orange" (Davis).	622
559	267 P. XXII. Aquarii	22 54 39	+3·2	−25 41·9	+19·2	6	Reddish. "Pale red" (Brodie).	625
560**	β Pegasi - -	22 58 55	+2·9	+27 32·4	+19·3	2·6	Rich golden. "Decided orange" (Davis). "Deep yellow" (Whitley).	627
561**	55 Pegasi - -	23 1 57	+3·0	+ 8 52·1	+19·4	4·6	Orange. "Decided orange" (Davis); "Orange yellow" (Whitley).	629
562	57 Pegasi - -	23 4 28	+3·0	+ 8 8·1	+19·4	5½	Reddish orange. "Decided orange" (Davis).	630

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563	W.B. XXIII. 48 Piscium.	23 6 8	+3·0	+ 4 27·4	+19·5	8	Orange.	—
564	Aquarii 286 - -	23 8 33	+3·1	−13 56·3	+19·5	7	Reddish. Double, A 7: B 10, Dist. 1·4″, ? Mag.	631
565	φ Aquarii - -	23 9 8	+3·1	− 6 35·3	+19·5	4·2	Deep orange. "Decided orange" (Davis). "Orange" (Whitley).	632
566	ψ¹ Aquarii - -	23 10 39	+3·1	− 9 37·9	+19·5	4·5	Orange. "Pale orange" (Davis).	633
567	χ Aquarii - -	23 11 40	+3·1	− 8 16·3	+19·6	5·2	Orange. "Decided orange" (Davis).	634
568**	8 Andromedæ -	23 13 4	+2·7	+48 28·1	+19·6	4·9	Fiery red. "Decided orange or reddish" (Davis).	635
569	2557 Arg. Cassiopeiæ	23 19 47	+2·6	+61 2·3	+19·7	8½	Reddish. In clus. h 2238.	639
570	71 Pegasi - -	23 28 27	+3·0	+21 56·8	+19·8	5·4	Deep orange. "Pale orange" (Davis).	643
571	λ Andromedæ -	23 32 40	+2·9	+45 55·0	+19·5	4·6	Orange. "Pale orange" (Davis).	644
572	77 Pegasi - -	23 38 18	+3·0	+ 9 46·3	+19·8	5·4	Deep orange. "Decided orange or even reddish" (Davis).	645
573	19 Piscium - -	23 41 15	+3·0	+ 2 55·9	+20·0	5·2	Decided red. "Deep orange" (Backhouse). "Pale red" (Davis). "Red" (Robinson). "Probably var."	648
574	4154 Groombridge Cephei.	23 47 30	+2·8	+74 59·1	+20·0	6½	Reddish orange -	651
575	235 P. XXIII. Pegasi.	23 51 36	+3·0	+22 3·5	+20·0	6	Reddish. "Slightly red" (*Uran. Arg.*).	653
576	9659 Lac. Sculptoris -	23 51 58	+3·1	−27 10·9	+20·0	6½	Reddish - -	654
577**	ψ Pegasi - -	23 52 40	+3·0	+24 35·7	+20·0	4·6	Reddish yellow. "Decided orange" (Davis).	655
578**	R Cassiopeiæ -	23 53 19	+3·0	+50 49·9	+20·0	Var. 5–12	Very red "Decided orange or reddish" (Davis).	656
579**	6259 Rad. Cassiopeiæ	23 56 8	+3·0	+59 47·9	+20·0	8	Very fiery red. Blue star of mag. 9 near.	658
580*	30 Piscium - -	23 56 49	+3·1	− 6 34·2	+20·0	4·6	Fiery red. "Decided orange" (Davis). "Orange red" (Robinson).	—

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Rejected Stars.

After the principal catalogue was completed I thought it might be desirable to preserve some record of the stars which had been rejected* from it on the ground that they were not of sufficiently decided colour to be ranked as "orange," much less as "red" stars. There was evidence to show, however, that peculiarities of eye, and perhaps also of instrument, affect the judgment of some observers with respect to certain stars, and that one man would call "orange" a star which another would write down as "yellow," or it might be, "tinged." By putting together these doubtful stars in a catalogue by themselves the door is left open for their examination by other observers in future years who may be able, perhaps, in some instances, to show that particular stars must have changed colour. As things stand at present, however, it must be taken that to the best of my judgment these stars cannot with propriety be included in a catalogue of "red" stars.

I have, therefore, treated them simply as raw material, and have made no attempt to bring their places up to a common epoch, or to verify the places or particulars of magnitude, merely giving these in the form in which they were brought under my notice by correspondents or otherwise. I may state, however, that with very few exceptions all the rejected stars visible in England have been examined by myself, and many of them have been observed by different members of the Section.

Star.	R.A.	Decl.	Epoch.	Mag.
— Cassiopeiæ	0 3 38	+63 20·4	1890	9
— Cassiopeiæ	0 9 5	+65 29·8	1890	8½
ζ Andromedæ	0 41·0	+23 37	1880	4·4
— Cassiopeiæ	0 50 59	+67 5·9	1890	8¾
2 Ursæ Minoris	0 53 39	+85 39·1	1890	5
239 Groom. Cassiopeiæ	1 0 36	+52 54·5	1890	6¼
Arg. +51: 243	1 5	+51 47	1900	8·7
2393 Lal.	1 15	+ 5 38	1900	7·7
36 Espin Persei	1 36 39	+57 53·0	1900	6
χ Eridani	1 51·1	−52 14	1875	3·6
39 Arietis	2 40·8	+28 45	1880	4·6 (Whitley).
5:72 Lal. Persei	2 43 30	+57 52·6	1890	7½
ρ Persei	2 57·5	+38 22	1880	3·7 (Whitley).
— Tauri	3 36 2	+14 26·4	1890	8
6921 Lal. Eridani	3 38 28	− 9 57·3	1890	7⅓
Arg. +23: 519	3 40	+33 53	1900	8·5
220 P. III. Tauri	3 55 45	+ 9 41·4	1890	6]

* This expression is intended to cover the case of stars which at one time it was seriously intended to include as possessing claims to be regarded as "orange" or "red." This appendix does not embrace a large number of stars with some tinge of colour which are included in Birmingham's well-known and valuable catalogue, and Schjellerup's less known but also valuable catalogue.

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Star.	R.A.	Decl.	Epoch.	Mag.
45 Espin Tauri	3 58 10	+12 12·0	1890	7½
47 Tauri	4 7 57	+ 8 59·1	1890	5
49 P. IV. Tauri	4 8 51	+ 9 43·8	1890	5¼
8154 Lal. Eridani	4 15 14	− 6 30·4	1890	6¼
2 Espin Aurigæ	4 38 38	+32 14·7	1890	8½
149 Espin	4 47 12	+22 35·7	1890	9
ε Aurigæ	4 49·2	+32 58	1880	2·7 (Whitley).
— Orionis	4 53 14	+12 40·0	1890	8¾
150 Espin Aurigæ	4 55 50	+38 54·8	1890	8½
276 P. IV. Orionis	4 56 11	+ 0 33·6	1890	6¼
— Orionis	5 0 57	+ 0 24·2	1890	9
152 Espin Aurigæ	5 4 15	+43 34·5	1890	8
9744 Lal. Orionis	5 4 26	− 0 42·1	1890	6½
5 Espin Aurigæ	5 10 59	+40 10·6	1890	7 ? Identity.
51 Espin Orionis	5 12 44	− 8 21·9	1890	8½
— Orionis	5 18 1	− 9·25·9	1890	8½
φ Aurigæ	5 20·4	−34 24	1890	5·4 (Whitley).
6 Espin Aurigæ	5 22 39	+40 25·5	1890	7½
7 Espin Aurigæ	5 26 31	+41 2·3	1890	7½
56 Espin Aurigæ	5 40 33	+44 48·0	1890	9
τ Aurigæ	5 40·9	+39 8	1880	4·6
ν Aurigæ	5 43·2	+39 7	1880	4·2 (Whitley).
Arg. +32 : 1118 Aurigæ	5 46 6	+32 9·3	1890	8½
11 Espin Aurigæ	5 46 19	+40 21·8	1890	8
γ Pictoris	5 47·5	−56 12	1875	4·3
Arg. +20 : 1171 Orionis	5 49 5	+20 26·9	1890	8
14 Espin Aurigæ	6 4 56	+32 43·3	1890	6
15 Espin Aurigæ	6 6 48	+33 16·3	1890	7
5 Monocerotis	6 9 30	− 6 14·4	1890	4¼
16 Espin Aurigæ	6 9 52	+39 53·7	1890	7
17 Espin Aurigæ	6 10 2	+40 24·8	1890	8½
18 Espin Aurigæ	6 10 6	+39 30·6	1890	7
20 Espin Monocerotis	6 28	− 3 0	1886	7½
23 Espin Geminorum	6 38 36	+24 46·5	1890	7½
Arg. −8 : 1650 Monocerotis	6 52 49	− 8 52·6	1890	7
o^2 Canis Majoris	6 58 26	−23 40·4	1890	3
δ Canis Majoris	7 3 55	−26 13·1	1890	2
174 Espin Monocerotis	7 30 44	− 5 31·8	1890	8
175 Espin Canis Minoris	7 30 44	+ 2 19·0	1890	8¾
27 Espin Geminorum	7 35 43	+29 5·2	1890	8
κ Cancri	9 1·3	+11 9	1880	5·0 (Whitley).
18688 Lal. Hydræ	9 24 8	+20 16·0	1890	6½
υ Ursæ Majoris	9 42·5	+59 36	1880	4·0 (Whitley).
3380 B.A.C. Sextantis	9 4·8	+ 6 20	1900	6·5
29 Espin Leonis	9 51 46	+ 8 53·7	1890	7
γ Leonis	10 13 54	+20 23·8	1890	2
31 Espin Leonis	10 52 45	+20 13·4	1890	7
1917 H.P. Crateris	10 54 5	−15 45·8	1890	6¼
60 Leonis	10 56 27	+20 46·3	1890	4½
α Ursæ Majoris	10 56 56	+62 20·7	1890	2
75 Leonis	11 11 37	+ 2 37·0	1890	5½
ν Virginis	11 39·7	+ 7 12	1880	4·2
ο Virginis	12 0	+ 9 17	1900	4·3
17 Virginis	12 16 5	+ 5 55·2	1890	7

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Star.	R.A.	Decl.	Epoch.	Mag.
— Comæ Berenicis	12 23 40	+28 54·2	1890	9
β Corvi	12 28·1	−22 44	1880	2·8 (Whitley).
23736 Lal. Virginis	12 38 3	− 0 50·1	1890	8½
δ Virginis	12 50 3	+ 3 59·7	1890	3¾
1944 Groom. Draconis	12 52 45	+67 50·2	1890	6½
9 Draconis	12 55 57	+67 11·5	1890	5½
Arg. + 5 : 2708	12 58	+ 5 43	—	8, var.
σ Virginis	13 12 3	+ 0 3·0	1890	5
61 Virginis	13 12 40	−17 41·8	1890	4¾
24769 Lal. Virginis	13 16 14	−13 50·5	1890	7
4479 B.A.C. Canum Venat.	13 18 54	+37 36·3	1890	6½
o Virginis	13 38	+ 4 3	1900	6·5
i (10) Draconis	13 48 11	+65 15·9	1890	4¾
95 Virginis	14 0 53	− 8 47·3	1890	5¾
— Virginis	14 10 57	−16 0·8	1890	8¾
— Virginis	14 23 55	− 5 29·5	1890	8
4825 B.A.C. Böotis	14 30 8	+37 6·5	1890	6½
— Libræ	14 34 31	−14 49·6	1890	8
Arg. + 32 : 2504 Böotis	14 36 33	+32 1·5	1890	8
— Böotis	15 5	+52 12	1885?	8?
6 Serpentis	15 15 24	+ 1 7·0	1890	5½
— Libræ	15 16 10	−28 47·2	1890	8½
S Serpentis	15 17	+ 4 40	1900	8·3 var.
ι Draconis	15 22 29	+59 21·1	1890	3½
ζ¹ Libræ	15 23	−16 22	1900	6·2
11 Serpentis	15 27 18	+ 0 48·8	1890	6
μ Coronæ Bor.	15 31·2	+39 22	1890	5·4 (Whitley).
γ^4 Serpentis	15 31 22	+15 28·0	1890	6½
α Serpentis	15 39	+ 6 44	1900	2·7
— Libræ	15 41 34	−19 47	1880?	8
ω Serpentis	15 44 44	+ 2 32·0	1890	5
κ Coronæ Borealis	15 46·7	+36 2	1880	4·7 (Whitley).
T Coronæ Borealis	15 55	+26 12	1900	9·5 var.
— Scorpii	16 3 3	−26 9·6	1890	7½?
29441 Lal. Serpentis	16 4 5	+ 1 6·8	1890	7
ε Ophiuchi	16 12 29	− 4 25·3	1890	3½
30593 Lal. Ophiuchi	16 43 42	+ 0 7·0	1890	9
30790 Lal. Ophiuchi	16 50 31	+ 1 35·9	1890	8
κ Ophiuchi	16 52 27	+ 9 32·8	1890	3½
61 Herculis	16 59 36	+34 33·6	1890	7
70 Espin Herculis	16 59 6	+35 33·8	1890	6½
μ Herculis	17 13 15	+33 13·0	1890	5
λ Herculis	17 25 17	+26 11·6	1890	4¼
β Draconis	17 27 57	+52 22·9	1890	3
5986 B.A.C. Herculis	17 35 48	+31 15·7	1890	6½
β Ophiuchi	17 38 2	+ 4 36·8	1890	3
— Serpentis	17 38 28	−18 36·4	1890	8½
— Ophiuchi	17 41 57	− 3 36·3	1890	8
Albany (A.G.) 5962	17 47	+ 1 8	1900	6·7
ξ Draconis	17 51 35	+56 53·3	1890	4
A (104) Herculis	18 7 47	+31 22·7	1890	5
Arg. + 22 : 3303 Herculis	18 8 15	+22 48·1	1890	7½
Albany (A.G.) 6154	18 9	+ 2 22	1900	7
Albany (A.G.) 6167	18 11	+ 2 21	1900	6·3
η Sagittarii	18 10 11	−36 47·8	1890	3
33933 Lal. Serpentis	18 13 49	+ 0 47·9	1890	8
33896 Lal. Herculis	18 16 57	+25 0·2	1890	7½

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Star.	R.A.	Decl.	Epoch.	Mag.
— Serpentis	18 18 17	− 1 38·3	1890	7
60 Serpentis	18 23 57	− 2 3·4	1890	5½
34307 Lal. Aquilæ	18 27 16	− 5 14·5	1890	7½
123 P. XVIII. Clyp. Sob.	18 30 12	− 6 49·9	1890	7
34507 Lal. Aquilæ	18 32 40	−13 52·6	1890	8
— Serpentis	18 32 42	+11 21·3	1890	8½
83 Espin Lyræ	18 33 46	+37 41·0	1890	7
Arg. + 33 : 3192 Lyræ	18 40 50	+33 4·5	1890	8
— Lyræ	18 46 40	+39 10	1885?	9 ?
32 Serpentis	18 50 6	− 6 28·8	1890	6
— Aquilæ	18 51 57	+ 0 18·5	1890	9
ε Aquilæ	18 54·2	+14 54	1880	4·1 (Whitley).
Arg. + 22 : 3549 Vulpeculæ	18 55 19	+22 39·7	1890	6½
o Sagittarii	18 58 5	−21 44·1	1890	4
89 Espin Lyræ	19 4 28	+38 58·7	1890	7
91 Espin Lyræ	19 13 22	+38 47·6	1890	6¾
93 Espin Sagittæ	19 16 43	+17 27·5	1890	9½
3 Cygni	19 20 54	+24 42·9	1890	6
— Vulpeculæ	19 21 30	+19 34·8	1890	6
128 P. XIX. Vulpeculæ	19 21 40	+19 40·3	1890	6¼
μ Aquilæ	19 28·2	+ 7 8	1880	4·7 (Whitley).
97 Espin Vulpeculæ	19 31 12	+23 36·3	1890	8
98 Espin Vulpeculæ	19 35 13	+17 38·4	1890	8
104 Espin Aquilæ	19 42 18	+ 9 45·9	1890	8
ξ Aquilæ	19 48·5	+ 8 9	1880	4·9 (Whitley).
— Aquilæ	19 48 46	+ 9 25	?	? (Prince).
181 Espin Cygni	19 56 30	+30 31·2	1890	9¼
Arg. + 36 : 3820 Cygni	19 57 13	+36 47·6	1890	7
19 Vulpeculæ	20 7 12	+26 29·0	1890	5¾
Arg. + 36 : 3956 Cygni	20 10 25	+36 19·6	1890	8
38988 Lal. Aquilæ	20 13 21	+ 0 15·2	1890	8¾
ν Capricorni	20 14·0	−13 8	1880	4·7 (Whitley).
115 Espin Cygni	20 17 37	+53 14·2	1890	7
116 Espin Cygni	20 20 46	+39 47·5	1890	7½
69 Aquilæ	20 23·4	− 3 17	1880	5·2 (Whitley).
— Aquilæ	20 32 41	+ 0 37·6	1890	8½
3 Aquarii	20 41·4	− 5 28	1880	4·6 (Whitley).
ε Cygni	20 41 45	+33 33·4	1890	2¾
120 Espin Cygni	20 45 4	+45 26·7	1890	8½
— Delphini	20 46	+ 8 15	1885?	? (G.F.C.)
124 Espin Cygni	21 6 40	+47 12·4	1890	7½
7 Pegasi	21 36·8	+ 5 11	1890	5·4 (Whitley).
129 Espin Cygni	21 37 53	+48 41·5	1890	8¾
130 Espin Cephei	21 38 41	+70 17·1	1890	8
47 Capricorni	21 40 24	− 9 47·0	1890	6½
ν Pegasi	21 59·6	+ 4 28	1880	4·8 (Whitley).
134 Espin Lacertæ	22 6 30	+39 9·9	1890	7¼
35 Pegasi	22 22 17	+ 4 8·7	1890	5
β Piscis Australis	22 25 15	−32 54·6	1890	5

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Star.	R.A.	Decl.	Epoch.	Mag.
λ Pegasi - - -	22 40·9	+22 56	1880	4·2 (Whitley).
g^2 Aquarii - - -	22 41 39	−20 31·0	1890	5½
μ Pegasi - - -	22 44·2	+23 58	1880	3·7 (Whitley),
λ Aquarii - - -	22 46 52	− 8 9·9	1890	3¾
δ Aquarii - - -	22 48·3	−16 28	1880	3·4
138 Espin Lacertæ - -	22 52 25	+42 25·1	1890	7
— Piscium - - -	22 55 39	+ 0 29·6	1890	8½
56 Pegasi - - -	23 1·3	+24 49	1880	4·9 (Whitley).
94 Aquarii - - -	23 13 28	−14 3·4	1890	5¼
262 Bess. Pegasi - -	23 14 44	+22 29·4	1890	7
46112 Lal. Pegasi - -	23 27 0	+23 14·3	1890	7
78 Pegasi - - -	23 38 27	+28 45·1	1890	5
ρ Cassiopeiæ - - -	23 48 53	+56 53·2	1890	4⅓
W.B. XXIII, 1090 Piscium -	23 54 56	+ 0 27·1	1890	8¾

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SECTION FOR THE OBSERVATION

OF

MARS.

DIRECTOR.—E. M. ANTONIADI, F.R.A.S.

REPORT OF THE SECTION, 1898—1899.

PART I.

PROLEGOMENA.

1. The Apparition of 1898–1899.

This opposition of Mars was, on the whole, a favourable one. Although the planet which, in 1896, approached us to within 0·561 (52,040,000 miles), was not nearer than 0·651 (60,390,000 miles) on 1899, January 15, yet its great northern declination atoned, to European astronomers, for its reduced disc, which, even at maximum, was not greater than 14″·76.

Phenomena.

Passage of Mars through Perihelion	1898, April 30.
Summer Solstice of S. hemisphere Winter Solstice of N. hemisphere	1898, May 31.
Autumnal Equinox of S. hemisphere Spring Equinox of N. hemisphere	1898, Nov. 6.
Passage of Mars through Aphelion	1899, April 8.
Winter Solstice of S. hemisphere Summer Solstice of N. hemisphere	1899, May 24.

The latitude of the centre of the disc was negative early in the apparition, but became positive on 1898, August 19, when the earth passed through the plane of the Martian equator.

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2. The Work of the Section.

The following are the names of the Members having joined the Mars Section in 1898–1899.

Observer.	Locality.	Aperture of Instrument in Inches.	No. of Drawings sent to the Association.
ANTONIADI, E. M., F.R.A.S.	Juvisy, *France* -	$\left\{\begin{matrix}10\frac{1}{2}\text{ O.G.}\\6\frac{1}{2}\text{ Spec.}\end{matrix}\right\}$	65
ATTKINS, E. - -	Highgate, London -	$6\frac{1}{2}$ Spec.	11
BROWN, G. L. - -	Stirling, Scotland -	$10\frac{1}{4}$ Spec.	5
CORDER, H. - - -	Bridgewater -	$6\frac{1}{2}$ Spec.	12
CROWLEY, L. A. - -	Paris, *France* -	7 O.G.	5
HALL, W. J. - -	Nantwich, Cheshire	$4\frac{7}{8}$ Spec.	5
KEMPTHORNE, Rev. P. H., M.A., F.R.A.S.	Wellington College, Berkshire.	$12\frac{1}{2}$ Spec.	5
KILLIP, Rev. R., F.R.A.S. -	St. Annes-on-the-Sea, Lancashire.	5 O.G.	5
MEE, A., F.R.A.S. - -	Cardiff, Wales -	$8\frac{1}{2}$ Spec.	3
MOLESWORTH, Capt. P. B., R.E., F.R.A.S.	Trincomali, *Ceylon*	$12\frac{1}{2}$ Spec.	* 0
PHILLIPS, Rev. T. E. R., M.A., F.R.A.S.	Yeovil, Somerset -	$9\frac{1}{2}$ Spec.	20
TOWNSHEND, H. J. - -	Leeds - -	$9\frac{1}{2}$ Spec.	† 0
WILLIAMS, A. A. - -	Cardiff, Wales -	5 Spec.	7
WILLIAMS, A. STANLEY, F.R.A.S.	Brighton - -	$6\frac{1}{2}$ Spec.	1

A comparison of the preceding Table with those given in the last "Reports" will show a diminution in the membership as well as in the geographical extent of the Section—a change which, instead of going the other way, that is *pari passu* with the great increase in the Membership of the Association, seems to have unexpectedly followed the constant reduction of the Martian disc since 1892. If the change be cyclical, we may look forward for fuller collaboration in the immediate future.

It is fortunate, however, that, through the exertions of our European Members, there is no corresponding decline in the value of the results obtained.

* Capt. Molesworth was enabled to make 172 drawings of the planet during the apparition. These, however, were not presented to the Association, but merely sent to the Director for inspection. A summary of the Ceylon results is given in the present Report.

† The drawing shown on Plate III. Fig. 3., was only temporarily lent to the Director.

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A complete list of the 144 drawings of Mars sent to the Association in 1898–99 is given in the following Table :—

D stands for the diameter of the disc; ω and ϕ represent the longitude and the latitude of the centre of the disc.

No.	Observer.	Date.	D.	ω	ϕ
			″	°	°
1	Corder	1899, Jan. 19	14·7	0	+11·5
2	Antoniadi	„ Feb. 27	11·5	16	+ 8·7
3	Antoniadi	„ Feb. 25	11·7	24	+ 8·6
4	Antoniadi	„ Feb. 20	12·3	28	+ 8·5
5	Phillips	„ Feb. 26	11·6	29	+ 8·6
6	Corder	„ Jan. 14	14·8	32	+12·2
7	Phillips	„ Mar. 1	11·3	32	+ 8·7
8	Kempthorne	„ Feb. 21	12·1	34	+ 8·5
9	Brown	„ Jan. 16	14·8	36	+11·9
10	Antoniadi	„ Feb. 20	12·3	38	+ 8·5
11	Antoniadi	„ Feb. 25	11·7	39	+ 8·6
12	Antoniadi	„ Feb. 24	11·9	42	+ 8·6
13	Attkins	„ Feb. 24	11·9	42	+ 8·6
14	Antoniadi	„ June 17	5·3	44	+23·7
15	A. A. Williams	„ Feb. 26	11·6	44	+ 8·6
16	Corder	„ Jan. 13	14·7	48	+12·5
17	Antoniadi	1898, July 14	5·6	49	−10·3
18	Antoniadi	„ Aug. 19	6·2	51	− 0·2
19	Antoniadi	1899, Feb. 24	11·9	53	+ 8·6
20	Antoniadi	„ July 23	4·7	55	+26±
21	Stanley Williams	„ Feb. 23	11·9	57	+ 8·6
22	Killip	„ Feb. 22	12·0	58	+ 8·5
23	Hall	„ Jan. 14	14·8	59	+12·3
24	Phillips	„ Jan. 13	14·7	59	+12 4
25	Antoniadi	„ Feb. 24	11·8	60	+ 8·6
26	Kempthorne	„ Feb. 23	11·9	60	+ 8·6
27	Corder	„ Jan. 13	14·7	63	+12·5
28	Phillips	„ Apr. 3	8·5	70	+12·0
29	Attkins	„ Feb 23	11·9	71	+ 8·6
30	Corder	„ Feb. 16	12·7	72	+ 8·6
31	Phillips	„ Jan. 14	14·8	73	+12·3
32	Antoniadi	„ Feb. 17	12·6	79	+ 8·6
33	Antoniadi	„ Jan. 9	14·7	85	+13·1
34	Crowley	„ Feb. 17	12·6	86	+ 8·6
35	Antoniadi	„ Feb. 17	12·6	87	+ 8·6
36	Crowley	„ Jan. 9	14·7	87	+13·1
37	Phillips	„ Feb. 14	12·9	91	+ 8·7
38	Antoniadi	„ Jan. 9	14·7	92	+13·1
39	Antoniadi	„ Feb. 17	12·6	94	+ 8·6
40	Antoniadi	1898, July 8	5·5	99	−12·0
41	Antoniadi	1899, Feb. 17	12·6	101	+ 8·6
42	Antoniadi	„ Jan. 8	14·6	101	+13·2
43	Attkins	„ Feb. 17	12·6	106	+ 8·6
44	Antoniadi	„ Feb. 17	12·6	109	+ 8·6
45	Antoniadi	„ Jan. 8	14·6	116	+13·2
46	Phillips	„ Jan. 8	14·6	118	+13·2
47	Antoniadi	1898, Oct. 22	8·5	123	+13·7
48	Attkins	1899, Mar. 27	8·9	124	+11·1
49	Attkins	„ Feb. 17	12·6	130	+ 8·6
50	Antoniadi	1898, Oct. 22	8·5	131	+13·7
51	Antoniadi	1899, July 14	4·8	143	+25·8

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No.	Observer.	Date.	D.	ω.	φ.
			"	°	°
52	Antoniadi	1899, Feb. 10	13·3	153	+ 8·9
53	Phillips	„ Jan. 4	14·3	153	+13·8
54	Hall	„ Feb. 12	13·1	156	+ 8·8
55	Crowley	„ Feb. 10	13·3	158	+ 8·9
56	Antoniadi	1898, Sept. 13	6·9	159	+ 6·4
57	A. A. Williams	1899, Jan. 4	14·3	167	+13·9
58	Antoniadi	„ Feb. 10	13·3	168	+ 8·9
59	Crowley	„ Feb. 10	13·3	171	+ 8·9
60	Hall	„ Jan. 4	14·3	171	+13·8
61	Antoniadi	„ Mar. 16	9·9	178	+ 9·8
62	Killip	„ Mar. 15	10·0	178	+ 9·6
63	Phillips	1898, Dec. 31	14·2	180	+14·4
64	Antoniadi	1899, Mar. 14	10·0	189	+ 9·6
65	Antoniadi	„ June 2	5·7	189	+21·6
66	Antoniadi	„ July 9	4·9	189	+25·6
67	Antoniadi	„ Feb. 10	13·3	194	+ 8·9
68	Antoniadi	„ June 1	5·7	194	+21·5
69	Corder	„ Feb. 7	13·6	196	+ 9·0
70	Antoniadi	„ Feb. 10	13·3	201	+ 8·9
71	Crowley	„ Feb. 10	13·3	203	+ 8·9
72	Kempthorne	„ Feb. 2	14·0	205	+ 9·6
73	Hall	„ Feb. 3	13·9	206	+ 9·4
74	Attkins	„ Mar. 14	10·0	207	+ 9·6
75	Phillips	„ Feb. 1	14·1	210	+ 9·7
76	Antoniadi	„ Feb. 4	13·9	214	+ 9·4
77	Antoniadi	„ May 30	5·8	217	+21·3
78	Antoniadi	1898, Nov. 18	10·3	217	+16·3
79	Corder	1899, Feb. 1	14·1	224	+ 9·6
80	Antoniadi	„ Feb. 4	13·9	225	+ 9·4
81	Brown	„ Feb. 1	14·1	225	+ 9·7
82	Antoniadi	„ Jan. 28	14·3	228	+10·1
83	Antoniadi	„ May 30	5·8	228	+21·3
84	Attkins	„ Feb. 3	13·9	234	+ 9·4
85	Mee	„ Feb. 2	14·0	235	+ 9·6
86	Antoniadi	„ Jan. 28	14·3	236	+10·1
87	Antoniadi	„ Feb. 2	14·0	242	+ 9·6
88	Phillips	1898, Dec. 25	13·8	245	+15·1
89	Phillips	1899, Apr. 21	7·3	245	+14·9
90	Phillips	„ Mar. 14	6·3	249	+ 9·6
91	Antoniadi	1898, Dec. 21	13·4	249	+15·5
92	Hall	1899, Feb. 2	14·0	251	+ 9·5
93	Corder	1898, Dec. 27	13·9	253	+14·8
94	Antoniadi	1899, Apr. 19	7·5	254	+14·6
95	Attkins	„ Mar. 14	10·0	255	+ 9·6
96	Kempthorne	„ Feb. 2	14·0	255	+ 9·6
97	Antoniadi	1898, Dec. 21	13·4	257	+15·5
98	Antoniadi	1899, Feb. 2	14·0	257	+ 9·6
99	Antoniadi	„ May 27	5·9	257	+20·8
100	A. A. Williams	„ Feb. 2	14·0	259	+ 9·6
101	Antoniadi	„ Apr. 19	7·5	261	+14·6
102	A. A. Williams	1898, Dec. 26	13·8	262	+15·0
103	Killip	1899, Mar. 13	10·1	266	+ 9·5
104	Antoniadi	1898, Dec. 21	13·4	268	+15·5
105	Mee	1899, Jan. 27	14·4	268	+10·6
106	Antoniadi	1898, Dec. 20	13·3	269	+15·6
107	Antoniadi	„ Dec. 22	13·5	270	+15·4
108	Phillips	1899, Feb. 1	14·1	272	+ 9·7
109	Corder	„ Jan. 26	14·5	273	+10·4
110	Phillips	1898, Dec. 20	13·3	276	+15·6
111	Antoniadi	„ Dec. 22	13·5	277	+15·4

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No.	Observer.	Date.	D.	ω	φ
			″	°	°
112	Antoniadi	1898, Dec. 20	13·3	278	+15·6
113	Brown	1899, Jan. 26	14·5	280	+10·5
114	Antoniadi	1898, Dec. 20	13·3	284	+15·6
115	Brown	1899, Jan. 25	14·5	285	+10·6
116	Attkins	„ Jan. 26	14·5	288	+10·5
117	Phillips	„ Mar. 10	10·4	290	+ 9·2
118	Mee	„ Jan. 25	14·5	292	+10·6
119	Antoniadi	1898, Nov. 11	9·8	297	+15·9
120	Phillips	1899, Jan. 30	14·2	301	+ 9·9
121	Antoniadi	1898, Nov. 11	9·8	306	+15·9
122	Killip	1899, Jan. 26	14·5	306	+10·5
123	Attkins	„ Mar. 2	11·2	309	+ 8·7
124	Phillips	1898, Dec. 17	13·0	309	+15·9
125	Antoniadi	1899, Jan. 25	14·5	309	+13·1
126	A. A. Williams	„ Jan. 26	14·5	314	+10·4
127	Corder	„ Jan. 22	14·6	319	+10·9
128	Antoniadi	„ Feb. 27	11·5	320	+ 8·6
129	Antoniadi	„ Jan. 25	14·5	320	+10·6
130	Killip	„ Jan. 24	14·5	321	+10·7
131	A. A. Williams	„ Mar. 5	10·9	325	+ 8·9
132	Antoniadi	„ Feb. 27	11·5	327	+ 8·6
133	Antoniadi	„ Jan. 25	14·5	328	+10·6
134	Brown	„ Jan. 23	14·6	330	+10·9
135	Kempthorne	„ Jan. 27	14·4	330	+10·3
136	Corder	„ Jan. 19	14·7	331	+11·5
137	A. A. Williams	„ Jan. 23	14·6	332	+10·9
138	Antoniadi	„ Feb. 27	11·5	334	+ 8·6
139	Phillips	„ Apr. 9	8·0	337	+13·0
140	Antoniadi	„ July 30	4·7	340	+25·0
141	Attkins	„ Feb. 27	11·5	345	+ 8·6
142	Corder	„ Jan. 19	14·7	345	+11·5
143	Antoniadi	„ July 29	4·7	347	+26±
144	Phillips	„ Jan. 24	14·5	357	+10·7

The Section may be congratulated on having amongst its Members such skilful observers as Capt. Molesworth and the Rev. T. E. R. Phillips. The recent areographic work of the former, based on 172 drawings of the planet, is a worthy sequel to that made at the 1896–97 apparition, though the observer was now obliged to absent himself during the most favourable part of the planet's visibility. Meantime, the Rev. T. E. R. Phillips was even more successful in 1898–99 than two years previously. His results have been so fully confirmed from all quarters as to stamp him as one of the very first observers in the British Isles. Also, by his detection of the canals as edges to diffused shadings, the Rev. P. H. Kempthorne did more than anybody else in these days to increase our knowledge of those enigmatical lines. Work of a high order was further done by Messrs. Attkins and Brown, Hall, Corder, Mee, and A. A. Williams, while Messrs. Killip and Townshend supplied valuable drawings and notes. It is, however, to be regretted that the Section did not have the advantage of the full collaboration of Mr. Stanley Williams, though the few diagrams and notes sent are worthy of his work in the past.

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3. On the Representation of Uncertain Detail.

Rev. T. E. R. Phillips reports as follows on this important point:—

"Faint markings have been glimpsed now and then, and it "would be easy, by the 'scientific use of the imagination,' to "conjure them into lines and streaks harmonising with Schia- "parelli's charts, but I am careful to represent on my drawings "only what I feel I can see with certainty and hold with "tolerable steadiness."

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4. The Canals.

Notwithstanding the natural scepticism of many scientific men, every opposition brings with it its own contingent of confirmation of Schiaparelli's discovery of linear markings, apparently furrowing the surface of the planet Mars. The differentiation between objective and subjective in the dædalian phenomena presented by these appearances will be the work of future generations. But the value of the great Italian's results will be everlasting.

As at the last apparition, the canals have been seen by all the Members of the Section. Some notes as to their visibility will certainly be of interest here.

"I may say," says Mr. Attkins, "that I started work on Mars "in the hope that I should not see any of the so-called 'canals,' "and I was very much astonished at what I did see. I have, "however, no doubt about those I have shown, as every detail on "both occasions stood out perfectly defined, the air being very "steady and clear."

Writing under date 1898, December 16, the Rev. T. E. R. Phillips says:—

"Such canals as I have certainly seen have been very broad and "diffused, reminding one forcibly of Mr. Mee's 'amorphous "smudges' I have no doubt this appearance is due to im- "perfect seeing, and that, could I have observed under better "conditions, the markings would have seemed narrower and more "distinct." But on 1899, January 30:—"The canals in the "neighbourhood of the *Nilosyrtis* seemed almost Schiaparellian "in their sharpness and definiteness."

Now, next to observers so emphatic on the question, some Members of the Section might, perhaps, protest in finding their names included among the canal-seers.

"I have never joined the Mars Section, because I cannot see "canals," says Mr. Henry Corder, the valued late Director of the Meteoric Section of the Association, and no statement as to the contrary would be made here were the present "Memoir" to be a mere compilation of reports. But, inasmuch as the material composing it is based on a careful analysis of every shading shewn on the drawings to hand, it would be illogical to speak of some shadings, and say nothing of others. Like Mr. Mee, Mr. Corder shows diffuse markings at the exact positions of, and having a similar trend to, the Schiaparellian "canals." Hence the justification for including these features under that conventional name, And, it might be, that this very apparent incongruity pays the

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highest tribute to the accuracy of Messrs. Corder and Mee's observations.

The following Table shows the number of canals shown by the Members of the Section on their recent drawings:—

Observer.	Canals.				
	Schiap.	Lowell.	"New" 1896–97.	New, 1898–99.	Total.
Capt. Molesworth	75	3	4	3	85
Rev. T. E. R. Phillips	44	0	1	0	45
Antoniadi	41	0	2	1	44
Brown	35	1	1	1	38
Rev. P. H. Kempthorne	26	2	0	0	28
Attkins	22	0	1	0	23
Stanley Williams	17	0	0	0	17
Corder	15	0	1	0	16
Hall	10	0	1	0	11
Rev. R. Killip	9	0	0	0	9
Mee	7	0	0	0	7
Crowley	2	0	0	0	2
A. A. Williams	1	0	1	0	2
Townshend	0	0	1	0	1

The total number of canals seen by the Section in 1898–99 is exactly 99. Of these, 84 belong to Schiaparelli's charts, six to Lowell's, four to our 1896–97 chart, one to Cerulli's map of 1896, while four others were apparently seen for the first time at the past apparition.

A complete exposition of the names or symbols of these canals is given in the four following tables. Duplicity is indicated by a (*d*).

I. SCHIAPARELLI'S MAPS (1877–88).

Adamas.	*Ceraunius* (*d*).	*Galaxias.*
Æsacus.	*Cerberus* (*d*).	*Ganges* (*d*).
Æthiops.	*Chaos.*	*Gehon* (*d*).
Agathodæmon.	*Chrysorrhoas.*	*Gigas.*
Alcyonius.	*Clarius.*	*Gorgon* (*d* ??).
Amenthes.	*Cyclops* (*d*).	*Granicus.*
Antæus.	*Dardanus.*	*Gyndes.*
Anubis.	*Deuteronilus.*	*Hades* (*d*).
Arnon.	*Eosphoros.*	*Hebrus.*
Asclepius.	*Erebus.*	*Heliconius.*
Astaboras.	*Eumenides-Orcus.*	*Hiddekel.*
Astapus.	*Eunostos.* (D ?)	*Hyblæus.*
Astusapes.	*Euphrates.*	*Hydaspes.*
Athyr.	*Euripus.*	*Hydraotes.*
Boreas.	*Eurotas.*	*Iamuna* (*d*).
Boreosyrtis.	*Fevos.*	*Iaxartes.*
Callirrhoe.	*Fortuna.*	*Indus.*

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I. SCHIAPPARELLI'S MAPS (1877–88)—*continued.*

Iordanis.	*Orontes.*	*Sirenius.*
Iris.	*Oxus.*	*Styx.* (D)
Issedon.	*Pactolus.*	*Tanais.*
Kison.	*Phasis.*	*Tartarus.*
Læstrygon.	*Phison.*	*Thoth.*
Lethes.	*Phlegethon.*	*Titan.*
Nectar.	*Pierius.*	*Triton.*
Nepenthes.	*Plutus.*	*Typhonius.*
Nilokeras (*d*).	*Poros.**	*Uranius.*
Nilosyrtis.	*Protonilus.*	*Xanthus.*
Nilus (*d*).	*Pyriphlegethon.*	*Xenius.*

* A name given provisionally by the Director to Schiaparelli's unnamed canal, forming *Pharos Insula*, and putting into communication *Sinus Sabæus* with the *Syrtis Major*. Πόρος, in Greek, is a narrow *passage, strait,* or *channel.*

II. LOWELL'S CHART (1894).

"*Arosis.*"	"*Cantabras.*"	"*Eulæus.*"
"*Brontes.*"	"*Elison.*"	"*Hypsas.*"

III. CANALS OF THE 1896–97 CHART.

Ω and Φ represent areographic longitude and latitude respectively.

Symbol, 1896–97.	Name.	Discovered by.	Extent (1898–99). From Ω	From Φ	To Ω	To Φ
			°	°	°	°
A	"*Iamuna II.*"*	Molesworth, 1896	35	− 1	40	−12
E	"*Hyblæus II.*"*	" "	208	+33	214	+ 9
I	"*Rhesus*"†	Stanley Williams, 1890.	254	− 3	279	+ 8
L	"*Nasamon*"‡	Lowell, 1894	265	+40	282	+30
—	"*Sitacus*"§	Cerulli, 1896	298	+40	354	+ 8

* Names given by Captain Molesworth.

† Christened by Cerulli.

‡ Name given to this canal by the Director, from its African vicinity. Lowell and Cerulli both call it "*Astapus*," though its course makes an angle of 45° with Schiaparelli's *Astapus*. Hence the necessity of a new name for this important marking.

§ Lowell called "*Sitacus*" a line running from the preceding fork of *Sinus Sabæus* to the northern end of *Syrtis Major*. But the canal seen by the Members of the Section in 1898–99 unites the same fork to *Coloe Palus*, thus being identical with Cerulli's "*Sitacus.*"

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IV. NEW CANALS SEEN IN 1898–99.

Symbol, 1898–99.	Name (in Cerulli's Map, 1900).	Discovered by.	Extent. From Ω	From Φ	To Ω	To Φ
A	ALANDER	Molesworth	42°	+43°	98°	+30°
B	CHARADRUS	,,	106	+30	150	+20
C	- - -	Brown	220	+19	232	+14
D	"*Axon*"	Antoniadi / Molesworth	232	+30	265	+40

It is evident from the above tables that very few canals were seen double in 1898–99.

CANALS IN THE DARK REGIONS.—"I have been fortunate "enough to trace several of Lowell's canals traversing the *Maria*. "These features appear to me in prolongation of, and are "obviously connected with, the true canals."—(Captain Molesworth.)

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5. The Canals considered as Edges to Faint Shadings. A Step towards the Solution of the Mystery.

The most important feature of the apparition in connexion with the canals is the detection, made by the Rev. P. H. Kempthorne, that a considerable number of them are merely the edges of diffused shadings. At least a dozen canals were thus seen by the Rev. P. H. Kempthorne. Such observations are of the highest import, as throwing immense light on an obscure corner of science. Probably optical phenomena have something to do with the visibility of the canals. Meantime, the sensibility of some eyes in detecting almost insensible half-tones stands in curious opposition to the inability of others in that line.

Messrs. Corder, Molesworth, Phillips, A. A. Williams, and the Director, also saw a very few canals as borders to faint dusky areas. But the stone added to the edifice of truth here by Mr. Kempthorne is weightier alone than the sum of those brought by the other Members of the Section together.

The idea that some of the canals might be due to the edges of shadings was enunciated by Mr. Maunder in 1882.

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6. The Lakes.

The number of lakes shown by each Member of the Section on the drawings to hand is as follows:—

Observer.	Lakes.			
	Schiap.	Lowell or Cerulli.	"New."	Total.
Capt. Molesworth	14	5	6	25
Rev. T. E. R. Phillips	12	2	3	17
Antoniadi	13	0	1	14
Brown	8	1	4	13
Attkins	7	0	1	8
Rev. P. H. Kempthorne	6	0	1	7
Hall	6	0	1	7
Stanley Williams	4	0	0	4
Corder	2	0	1	3
Mee	1	0	1	2
Crowley	2	0	0	2
Rev. R. Killip	1	0	0	1
A. A. Williams	1	0	0	1
Townshend	0	0	0	0

In all 33 lakes are recorded. Of these, 18 are Schiaparelli's, 4 Lowell's, 1 Cerulli's, and 10 new. The latter seem to have mostly been seen for the first time in 1898–99.

I. SCHIAPARELLI'S MAPS (1877–88).

Arethusa Lacus.	*Mæotis Palus.*	*Siloe Fons.*
Coloe Palus.	*Mœris Lacus.*	*Sirbonis Palus.*
Hecates Lacus.	*Niliacus Lacus.*	*Solis Lacus.*
Hephæstus.	*Nodus Gordii.*	*Stymphalius Lacus.*
Ismenius Lacus.	*Phœnicis Lacus.*	*Tithonius Lacus.*
Lunæ Lacus.	*Propontis.*	*Trivium Charontis.*

II. LOWELL'S CHART (1894).

"*Ammonium.*"	"*Lucus Maricæ.*"
"*Castalia Fons.*"	"*Nodus Gordii.*"

N.B.—Schiaparelli called *Nodus Gordii* the intricate dusky rendezvous of *Eumenides*, *Sirenius*, and *Gigas*, with centre at $\Omega = 127°$, $\Phi = 0°$. This is not Lowell's "*Nodus Gordii*," a small dot strung on the *Eumenides* towards $\Omega = 146°$. The beaded appearance of the canal *Eumenides-Orcus* was first recognised by Mr. Walter F. Gale, F.R.A.S., of Sydney, New South Wales, during the very favourable apparition of 1892.

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III. CERULLI'S CHART (1900).

"*Pambotis Lacus*," on intersection of *Cyclops*, *Cerberus*, *Eunostos*, &c.

IV. NEW LAKES (1898–99).

Symbol.	Discoverer.	Approximate Position. Ω	Φ	Symbol.	Discoverer.	Approximate Position. Ω	Φ
	PALLADIUS LACUS						
a*	Phillips	20	+30	f	Brown	225	+39
b	Molesworth	100	+29	g	Brown	262	+34
b	Phillips	100	+29	h	Several observers.	280	+54 CASIUS L.
c	Molesworth	122	−9				
d	Molesworth	167	+28	i	Molesworth	312	+25 ASTABORAE F.
e	Brown	217	+39	j	Molesworth	348	+18

* Different from the lake *a* of our 1896–97 chart.

7. The Colours of the Disc.

"Little colour has been noted on the disc," says Mr. Attkins. "Occasionally a very faint red on certain regions has been seen, "and also a bright yellow tint has been noticed. The seas have "generally appeared greyish (rather dark) with, perhaps, a faint "shade of green."

A blue tinge has often been noted in the *Maria* by Capt. Molesworth. Mr. Hall found them rather greenish. On January 4, Rev. T. E. R. Phillips remarked that the "planet appeared very "ruddy in morning light."

8. The Projections on the Terminator.

Capt. Molesworth forwards the following notes concerning these phenomena:—

"1898, August 15,—Projection near N. end of terminator, "actual not optical (*Baltia*?)

"August 19.—Optical (*Edom*).

"August 21.—Optical (white patch near *Hammonis Cornu*).

"September 9.—Slight bulge suspected on terminator close to its N. end (*Arcadia*?).

"September 12.—Minute white point suspected close to terminator just N.E. of *Lacus Phœnicis* (not a true projection).

"No irregularities noticed on limb."

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9. The Fading of the Maria.

"The most noteworthy point during the period of these "observations," says Capt. Molesworth, "was the faintness of "all the *Maria* during August. The fading began towards the "end of July (50 to 60 days after the winter solstice of the N. "hemisphere). The *Maria* were so faint towards the end of "August and beginning of September that they were only "perceptible with great attention. The first sign of darkening "was noted on September 20 (112 days after the solstice and "48 before the equinox). After this date the *Maria* rapidly "recovered their normal darkness. It will be noticed that this "recovery of tone was just antecedent to the unveiling of the "N. polar cap, which was very indefinite up to September 28. "The faintness of the *Maria* was not caused by cloud or mist, "as, with sharp definition, the details, although so faint, were "seen quite distinctly; the edges of the *Maria* being clear cut, "and not 'fuzzy' as if obscured in any way. The fading appears "to have been due to a definite change in the *Maria* themselves, "and was shared by the larger lakes, *Lacus Solis*, *Lacus Lunæ*, "*Mare Acidalium*, *Trivium Charontis*, &c. These observations "confirm those of Lowell in 1894, when a similar general fading "of the *Maria* was noticed about 60 days after summer solstice "of the S. hemisphere (Lowell 'Mars,' 1896, p. 120). The "change, therefore, is probably seasonal, and possibly connected "with the development of the N. polar cap and its sudden "return to distinctness" (*see* p. 102).

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10. On the Transparency of the Martian Atmosphere.

On 1899, January 25, the Director found the *Mare Tyrrhenum* very dark right up the *p* limb, an observation which has been frequently confirmed subsequently. The *Boreosyrtis* also was almost black when rising on the limb or terminator. This remarkable visibility of dark spots through so thick an atmospheric layer shows us, beyond doubt, that the gaseous envelope of Mars is exceedingly transparent, and, to a large extent, destitute of anything capable of scattering sunlight. On Mars, therefore, the sky ought to be nearly black in broad daylight, a circumstance which would enable faint stars to be easily visible.*

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* This idea was suggested by M. Flammarion and the Director in their joint paper on Mars, 1898–99, published in the *Bulletin de la Société Astronomique de France*, for September 1899.

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PART II.

THE OBSERVATIONS.

Introductory.

In dealing with so large a number of drawings, Mr. Maunder's excellent programme of 1892 was followed in arbitrarily dividing the planet's surface into eight sections, of which six, having a mean breadth of 60° in longitude, extend from + 60° to — 60° of latitude, while the remaining two sections deal with the polar regions.

Section.	Breadth.	Limits of Ω	Limits of Φ	Region.	Drawings.
I.	60°	310° to 10°	+ 60° to — 60°	*Sinus Sabæus* -	20
II.	45	10 „ 55	+ 60 „ — 60	*Auroræ Sinus* -	19
III.	65	55 „ 120	+ 60 „ — 60	*Solis Lacus* -	26
IV.	60	120 „ 180	+ 60 „ — 60	*Mare Sirenum* -	17
V.	70	180 „ 250	+ 60 „ — 60	*Mare Cimmerium*	28
VI.	60	250 „ 310	+ 60 „ — 60	*Syrtis Major* -	34
VII.	360	0 to 360	— 60 to — 90	South Polar Region	144
VIII.	360	0 „ 360	+ 60 „ + 90	North Polar Region	144

As in 1896–97, Schiaparelli's charming areographical nomenclature has been adopted here to the exclusion of any other. The dark areas have been systematically alluded to as seas, or anything signifying water (*Mare*, *Sinus*, *Fretum*, *Lacus*, *Palus*, "marsh," "shoal," "canal," &c.). The yellow background has received names conveying the idea of land (*Insula*, *Chersonesus*, *Promontorium*, *Pons*, "coast," &c.). All this is mere convention. We have no direct proof of the existence of water on Mars, while we seem to have some vague suspicions as to its absence. The kinetic theory of gases, as developed by Daniel Bernouilli, Joule, Maxwell, and Clausius, and, especially, as applied to planetary atmospheres by Dr. Johnstone Stoney, tends to show us the critical velocity on Mars to fall short of the maximum probable speed of the molecules of aqueous vapour. In that case the white polar caps would not be ordinary snow caps, but caps of solid carbonic acid. This heavy gas condenses, in fact, into an intensely white solid. Viewed in the face of our own earth's snow caps, the idea of endowing Mars with caps of such a deleterious substance seems far fetched. It must be borne in mind, however, that Maxwell's "probable maximum speed" is not a demonstrated verity, and that it is not at all certain that aqueous vapour is absent on Mars either. We gladly quit this field, lying, as it does, entirely beyond the pale of accurate knowledge.

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SECTION I.

Sinus Sabæus and Mare Erythræum.

$\Omega = 310°$ to $10°$; $\Phi = +60°$ to $-60°$.

[The words *East* and *West* are invariably used in their areographic sense.]

HAMMONIS CORNU.—This striking promontory is shown blunted by Corder and A. A. Williams. Brown saw it exactly as depicted on Schiaparelli's Charts, with a short canal* running on the mainland behind, from *Syrtis Major* to *Sinus Sabæus*, thus showing the Cape to be the S.E. point of *Pharos Insula*. Attkins found the *Cornu* "well-defined, rather pointed and whitish," and is supported in this by Phillips and Antoniadi. Molesworth also notes "that the region near *Hammonis Cornu* was . . . very "bright on (1898) August 21." On January 27, Kempthorne saw the promontory united to a white patch in the *Mare* southwards, at $\Omega = 312$, $\Phi = -18°$, extending as far as *Scylla et*

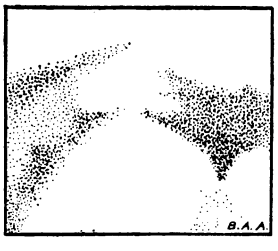

Fig. 1, January 27. (*Kempthorne.*)

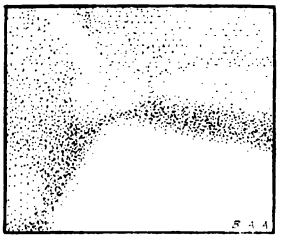

Fig. 2, January 30. (*Phillips.*)

Hammonis Cornu in January 1899.

Charybdis, and thus severing *Sinus Sabæus* from *Hellespontus* (Fig. 1), an observation which received full confirmation at the hands of Phillips, three days later (Fig. 2).†

SINUS SABÆUS.—The *Sinus* was found "dark, but not so much "so as *Dawes's Bay*," by Attkins, January 19; and "very pale" February 26 and March 1. Most Members show it uniform in tint, *Xisuthri Regio* being much less marked than in 1896–97. This half tone was, however, an easy feature to Antoniadi on February 27. Molesworth noticed, on 1898, August 21, "a pale "greenish grey tinge in the *Sinus Sabæus*." *Portus Sigeus*, the embouchure of the *Euphrates* was, as usual, a marked feature of the *Sinus*, appearing as a dark triangular spot on the drawings of Brown, Corder, Kempthorne, Molesworth, and Antoniadi. *Dawes's Forked Bay*, itself, was very dark to all the Members

* *See* page 70.

† Rev. T. E. R. Phillips suspected this appearance as early as 1898, November 13, when he noted that he thought "the *Sinus Sabæus* seemed "separated from the *Syrtis Major* by a lighter rift."

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having sent in drawings of this region. The forks are admirably represented by Molesworth and Phillips (Figs. 3 and 4), and

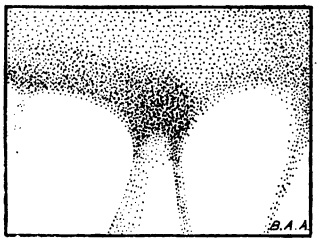

Fig. 3, November 3. (*Molesworth.*)

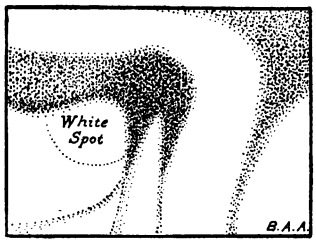

Fig. 4, January 24. (*Phillips.*)

The *Sinus Sabæus* region of Mars in 1898–99.

appeared sharp to Antoniadi on February 27 (Plate III., 6). They were, as a rule, incomparably darker than the canals to which they give rise, possibly as dark as any other region of the planet in 1898–99.

The bright coast all along the N. boundary of the *Sinus* is shown by Attkins and Killip (Plate III., 5).

FASTIGIUM ARYN is drawn shaded (the shading extending all over the space between the *Hiddekel* and the *Gehon*), by Kempthorne, who is supported here by Corder and Molesworth.

EDOM PROMONTORIUM.—"Its whiteness," says Phillips, "has "been such as to cast a glimmer of light across the *Sinus*, thus "almost uniting *Edom* with *Deucalionis Regio* by a bright "bridge." This cape was also white in 1896–97.

EDOM, itself, was described as "very bright," under $\omega = 330°$, by Brown, and "bright on limb," by Stanley Williams. In August 1898, Molesworth found it very white, "whereas at the "next presentation it was unusually dull, except when near the "terminator."

EDEN was seen slightly shaded by Brown, Corder, Kempthorne, and Molesworth, but Stanley Williams found it white on the limb.

THYMIAMATA appeared white near the terminator to Kempthorne.

AERIA.—Remarkably bright to Brown, even when central; seen bright when rising or setting by Attkins, Corder, Molesworth, and Antoniadi.

ARABIA.—Shaded on January 27, according to Kempthorne.

DIOSCURIA.—Slightly shaded on drawings by Brown and Corder.

CYDONIA was observed shaded on January 27, by Kempthorne.

SIRBONIS PALUS.—Brown shows the swamp as an extensive but faint shading, while Antoniadi glimpsed it as a small round

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dark spot on January 25, the cross canals *Typhonius* and *Phison** being invisible.

ISMENIUS LACUS.—This spot was well seen by Molesworth. Antoniadi found it difficult; but Phillips describes it as "quite distinct and easy," on February 24. A vast change would seem to have occurred here between 1886 and 1888. In 1886, Schiaparelli found the longitude of *Ismenius Lacus* equal to 335°. In 1888, the longitude of the western nucleus of the doubled lake was 345°, the centre at 342°. Meantime, the whole system *Euphrates-Arnon-Kison* seemed to have rotated some 10° W., round *Portus Sigeus* as a centre. Prof. Schiaparelli thinks that the errors of observations would scarcely amount to 2° or 3°, so that the evidence seems to be in favour of objective change on the planet. Considering the importance of the phenomenon, some measures of the longitude of *Ismenius Lacus*, as drawn by Members of the Section in 1898–99, would not be out of place here:—

Date.	Ω.	Observer.	Date.	Ω.	Observer.
1898.	°		1898.	°	
Aug. 22 -	335	Molesworth.	Nov. 11 -	322	Molesworth.
Sept. 30 -	332	Molesworth.			
Oct. 1 -	331	Molesworth.	1899.		
„ 2 -	338	Molesworth.	Jan. 24 -	339	Phillips.
Nov. 6 -	332	Molesworth.	„ 30 -	333	Phillips.
„ 9 -	333	Molesworth.	Feb. 27 -	337	Antoniadi.

It is obvious from these figures:—

(*a*) That the longitude of the lake did not go on increasing since 1888; and

(*b*) That, according to every probability, it rather decreased, so as to return to its original position.

ARETHUSA LACUS was seen by Molesworth on 1899, July 19, 20, 21, and 22, when the planet's disc was reduced to 4″·7; a very remarkable achievement indeed. Its longitude seemed to be towards 331°, or more than 10° less than in 1888. This confirms the idea of the return of the *Euphrates-Arnon-Kison* line to its primitive position.

SILOE FONS† was difficult to Antoniadi.

* The co-ordinates of *Sirbonis Palus* in 1879 were:—Ω = 327°, Φ = + 14°. Those of the marking called *Lacus Sirbonis*, by Schiaparelli, in 1888, were:—Ω = 333°, Φ = + 12°. The shift in longitude seems to have followed the change in the direction of the *Euphrates*, described in the next paragraph.

† This is different from *Dirce Fons*, drawn by Schiaparelli in 1883–84, on the intersection of *Deuteronilus*, *Iordanis*, *Xenius*, and *Oxus*, at Ω = 354°, Φ = + 36°. *Siloe Fons* (1888) lies on the intersection of *Deuteronilus*, *Gehon I.* and *II.*, *Xenius*, *Oxus*, and *Siris*, at Ω = 7°, Φ = + 34°.

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DEUCALIONIS REGIO is shown with its usual cigar shape by Corder, Molesworth, Phillips, A. A. Williams, and Antoniadi. All agree in drawing it fainter and duskier than the N. continent when in transit. The passage to the S. not very marked. The straight between *Deucalion* and *Thymiamata* is very dark on Killip's drawing, while Phillips does not represent it at all; having, moreover, seen the island much brighter and narrower than on Schiaparelli's charts. Molesworth shows the channel to the N. diffuse. *Deucalion* is one of those lands which brighten with the obliquity of the solar rays, and this phenomenon is very well depicted by Attkins.

NOACHIS has been drawn white on S. limb by Phillips, January 24.

HELLESPONTUS was seen dark by Kempthorne.

MARE ERYTHRÆUM.—All Members of the Section agree in giving to this area a greyish tinge. Owing, however, to the tilt of the axis, it was impossible, in 1898–99, to reconnoitre the appearance of the various half-tones with which its surface is diversified.

NEW LAKES:—

i $\Omega = 312°, \Phi = +25°$; detected by Molesworth.
j $\Omega = 348°, \Phi = +18°$; detected by Molesworth.

CANALS.

ARNON.—Seen by Molesworth: diffuse (1899, July 20, D. = 4″·7).

"AROSIS" (Lowell).—Partly shown by Kempthorne: diffuse.

"CANTABRAS" (Lowell).—Shown by Brown: diffuse.

DEUTERONILUS.—Brown: narrow.—Molesworth: diffuse.—Phillips: narrow.—Antoniadi: faint and difficult.

"EULÆUS (Lowell).—Seen diffuse by Molesworth, but not in the same course as Lowell's canal.

EUPHRATES.—Brown: narrow.—Molesworth: diffuse.—Phillips: rather broad.—Antoniadi: diffuse; very hard to see properly.

GEHON.—Attkins: single, running into *Niliacus Lacus*, February 24, but very broad February 27.—Brown: single, curved into *Mare Acidalium*, and very narrow.—Corder: edge of shading between it and *Hiddekel*.—Kempthorne: edge of shading between this canal and *Hiddekel*.—Killip: single, narrow.—Molesworth: diffuse at first, then sharp and single (November 3), and running as a curved line into *Sinus Acidalius*.—Phillips: invariably single and narrow, curving into the *Mare Acidalium*.—Stanley Williams: "seen conspicuously and undoubtedly double on March 2. Two distinct "streaks ran parallel to one another in a straight line from either inlet of "*Dawes's Forked Bay* to the *Mare Acidalium*. The canal was also seen "double on March 1. Schiaparelli's early maps of Mars show the *Gehon* "running in a curve to the *Mare Acidalium*, but it is noteworthy that on "the present occasion both components of the double canal seemed to run "in a perfectly straight line from *Dawes's Forked Bay* to the *Mare* "*Acidalium*. Considered as a single object the double *Gehon* was very "conspicuous."* Antoniadi: diffuse.

* Signor Cerulli supports Mr. Williams here. In spite, therefore, of the negative evidence afforded by other Members of the Section, the Director is inclined to consider the *Gehon* as having been really double in 1899.

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On the Chart (Pl. IV.) both the single (curved) and the double (straight) views of this canal are shown.

HIDDEKEL.—Attkins: very narrow.—Corder: edge of shade between it and *Gehon*.—Kempthorne: edge of shade between this canal and the *Gehon*.—Molesworth: diffuse.—Phillips: narrow.—Antoniadi: faint and narrow.

KISON.—Seen by Molesworth on 1899, July 22, when the planet's disc was reduced to 4″·7.

ORONTES.—Brown: narrow.—Kempthorne: edge of shade in *Eden*.—Molesworth: diffuse.—Phillips: narrow.—Antoniadi: narrow, though somewhat diffuse.

OXUS.—Seen by Molesworth as bounding a shade in *Cydonia*, when the breadth of the canal subtended $\frac{1}{10}''$.

PHISON.—Brown: faint.—Kempthorne: edge of shade in *Arabia*.—Molesworth: diffuse —Phillips: narrow.—Antoniadi: faint.

PIERIUS.—Brown: faint.—Molesworth: diffuse on 1899, June 16. D = 5″·4.—Antoniadi: diffuse.

"POROS."*—Shown by Brown: very narrow.

PROTONILUS.—Brown: well seen, narrow.—Kempthorne:—rather narrow, "edge of dusky area, quite sharp."—Molesworth: diffuse.—Phillips, narrow.—Antoniadi: narrow.

"SITACUS" (of Cerulli, not Lowell).—Corder: diffuse.—Antoniadi: very fine linear sensation; probably subjective.

TYPHONIUS.—Brown: narrow —Molesworth: diffuse.—Antoniadi: difficult. [Molesworth saw this canal produced into *Hadriacum Mare*.]

XENIUS.—Corder: very diffuse and indefinite.—Molesworth: edge of shading in S. *Cydonia*.

SECTION II.

Margaritifer Sinus, Auroræ Sinus, and Mare Acidalium.

$\Omega = 10°$ to $55°$; $\Phi = +60°$ to $-60°$.

MARGARITIFER SINUS.—This marking is drawn with its usual Schiaparellian outline by Brown. All Members agree in showing it much lighter in tint than the neighbouring dark *Sinus Sabæus*. Lowell's "Pearl" does not seem to have been seen.

AROMATUM PROMONTORIUM is shown bright by Molesworth. Attkins, Molesworth, Phillips, A. A. Williams, and Stanley Williams agree in drawing it a little more blunted than usual, while Brown, Kempthorne, and Antoniadi do not seem to corroborate this view. A light bridge was seen uniting this promontory to *Ogygis Regio* by Kempthorne (Pl. I., 3).

CHRYSE was found white when on transit by Brown; with a bright border by Attkins, February 21.

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* *See ante* p. 70.

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AURORÆ SINUS is described as "very dark" by Attkins and Phillips. Brown shows it rather faint, so also Corder and Crowley; Kempthorne very dark; Molesworth "abnormally "faint during the period of faintness,"* adding that from it, three great darker streaks have been seen crossing the *Mare*, two of which are apparently Lowell's "*Hipparis*" and "*Erannoboas*," the third being not identifiable, running, as it does, "in prolonga- ← CAICUS CANAL "tion of *Iamuna* to a point W. of *Thaumasia* near the estuary "of *Nectar*." A. A. Williams depicts the *Sinus* as rather faint, whilst Stanley Williams describes it "not very dark," in perfect agreement with Antoniadi. Two bridges are seen crossing *Auroræ Sinus* on Attkins' drawings. One of them is Lowell's "*Caicus*," the other Cerulli's "*Ogyges*." The latter was also seen by Hall.

LACUS NILIACUS.—Considerable confusion would seem to reign in the representation of this most interesting dark area. Attkins and Corder show it united to *Mare Acidalium*, the whole constituting a very marked, intensely dark spot, running S.W. Also, Hall (Fig. 10), Killip, and Molesworth (Fig. 5) did not clearly separate it from the sombre area to the N.

But Brown (Fig. 7), Kempthorne, Stanley Williams (Fig. 9), and Antoniadi (Fig. 8) show *Achillis Pons* as a very conspicuous feature, thus completely isolating the lake from below. Brown describes the *Lacus* as "a long ellipse," Kempthorne calls it "very dark," and Stanley Williams "not so dark as *Mare Acidalium*."

Phillips saw a lake (Fig. 6) E. of *Niliacus Lacus*, as stated at the end of this Section.†

ACHILLIS PONS was "at times very bright" to Brown and Kempthorne, invisible to Phillips, February 24, "plain and pretty bright" to Stanley Williams (Plate I., 4), and "one of the easiest "and most striking features of the planet" to Antoniadi (Plate I., 2). These discordances between observers are interesting, and show how the varying conditions of atmospheric steadiness and vacillating sensibility of the retina make us now detect extremely delicate details, and then miss some comparatively obvious markings.‡

MARE ACIDALIUM.—"Most astonishing sight," says Attkins, "quite the darkest and most prominent object on the disc. [On "January 19] at 11^h it was noted that this latter appeared *black*." Brown shows this spot very dark, with *Scheria Insula*, "occa- "sionally very bright," occupying its centre. All Members of the Section, having returned drawings of this region, dwell on the great darkness of *Mare Acidalium*, and agree in representing it as the darkest area of Mars. It is thus shown on the drawings

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* *See* p. 74.

† The Director is not quite sure that this is not *Siloe Fons*.

‡ On 1894, September 27, *Solis Lacus* was almost invisible to the Director when near the meridian for three consecutive hours, when, at last, upon nearing the *p* limb it suddenly appeared, for a fraction of a second, as an ink-black spot. Were the watch shorter, the latter appearance would not have been recorded, and the conclusion would be: "*Solis Lacus*, exceed- "ingly pale and indefinite."

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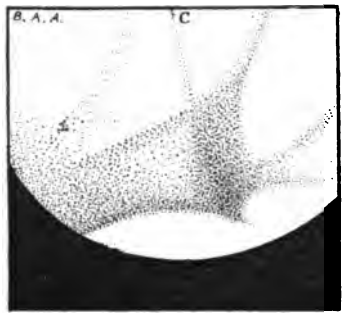

Fig. 5, 1898, November 3.
(*Molesworth.*)

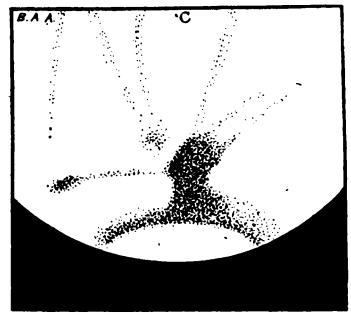

Fig. 6, 1899, March 1.
(*Phillips.*)

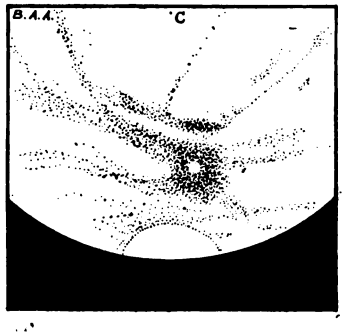

Fig. 7, January 16.
(*Brown.*)

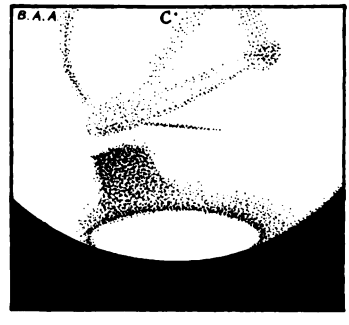

Fig. 8, February 24.
(*Antoniadi.*)

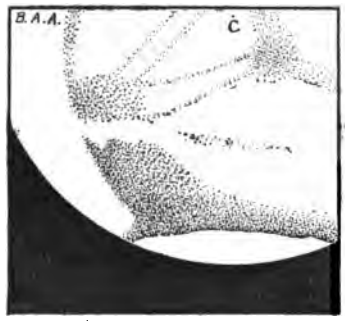

Fig. 9, February 23.
(*Stanley Williams.*)

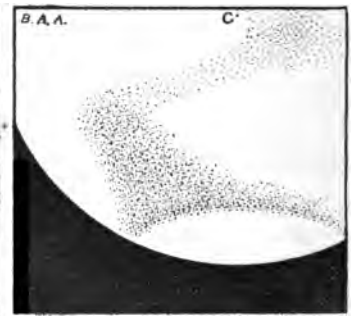

Fig. 10, January 4.
(*Hall.*)

The *Mare Acidalium* region of Mars in 1898–1899.

of Corder (Plate I., 1), Hall, Kempthorne, Killip, Molesworth, Phillips, A. A. Williams, and Stanley Williams. Among other particularities of this remarkable marking may be mentioned the accurate "bell-shaped" appearance given to it by Hall, and the fact that Stanley Williams saw it "very dark and definite on "the N. and preceding sides, but fainter towards the S. and "following sides," on February 23. When on the left of the

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central meridian, Antoniadi found it resembling "a cat seated "on the polar cap." Possibly its darkness was less marked than in 1896–1897, though the change might not be objective, inasmuch as it was just grazing the N. cap three or four years ago —a juxtaposition certainly called to enhance contrast. It is noteworthy, however, that Prof. Schiaparelli's observations from 1883 to 1888 have shown the darkness of *Mare Acidalium* to decrease with the sun's increasing altitude over its horizon.

PYRRHÆ REGIO is well indicated, as a narrow and slightly shaded streak, by Phillips; and Kempthorne saw it united to *Aromatum Promontorium*. It is also vaguely shown by Molesworth.

PROTEI REGIO "seems indicated in several of the drawings" (Molesworth).

ARGYRE is drawn very white on the limb by Molesworth and Antoniadi. Phillips says that "on limb" it was "quite com- "parable to the polar snows in brightness."

MARE ERYTHRÆUM.—The W. part of this vast dusky area was "grey, with a faint indigo tinge," according to Molesworth, while Stanley Williams lays stress on the unevenness in its tint.

NEW LAKE:—

a $\Omega = 20°$, $\Phi = +30°$; detected by Phillips.

This is S.E. of *Mare Acidalium*, and E. of *Niliacus Lacus*; it seems to be different from Molesworth's lake *a* of 1896–97 (last "Report," page 66 and chart, Plate I.), and also different, it would appear, from *Siloe Fons*.

CANALS.

CALLIRRHOE.—Seen by Brown: diffuse.—Molesworth: diffuse (1899, June 10; $D = 5''\cdot5$).—Antoniadi: merged into the sombre band encircling the N. Cap.

DARDANUS.—Brown: diffuse.—Kempthorne: narrow.—Molesworth diffuse; visible on disc of $5''\cdot6$.—Phillips: harsh, marked.—Stanley Williams: faint, narrow.—Antoniadi: sharp and easy.

HYDASPES.—Attkins: narrow.—Antoniadi: easy.

HYDRAOTES.—Brown: narrow.—Kempthorne: edge of shading N.—Molesworth: broad.—Phillips: verry narrow.

"HYPSAS" (Lowell). Shown by Kempthorne: harsh and dark.

IAMUNA.—Attkins: single, narrow.—Brown: single, exceedingly narrow. January 16.—Kempthorne: edge of shading between it and *Lunæ Lacus*.—Killip: diffuse.—Molesworth: diffuse.—Phillips: single; "on March 1, "in good air, it came out as a narrow and well-defined line."—Stanley Williams: "certainly double, both bands faint and diffuse, just like the other "canals, not sharply defined lines," February 23.—Antoniadi: vague and diffuse.

"IAMUNA II" (Molesworth).—Seen by Molesworth in the same position as in 1896–1897. This is the canal A of our last chart.

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IAXARTES.—Molesworth: diffuse (1899, June 8; D = 5″·6).

INDUS.—Brown: narrow.—Kempthorne: narrow.—Killip: diffuse.—Molesworth: diffuse.—Phillips: narrow.—Stanley Williams: diffuse.—Antoniadi: diffuse.

IORDANIS.—Molesworth: diffuse (1899, June 7; D = 5″·6).—Phillips: narrow.

NILOKERAS.—Attkins: very dark and triangular in shape, point towards *Lunæ Lacus*, February 24; but narrow the day before.—Brown: diffuse.—Corder: very broad and extended.—Hall: broad and diffuse.—Molesworth: double, *parallel lines*, October 27.—Phillips: anomalously double.—Stanley Williams: "almost certain anomalously double."—Antoniadi: suspected anómalously double.

SECTION III.

Solis Lacus.

$\Omega = 55°$ to $120°$; $\Phi = +60°$ to $-60°$.

LUNÆ LACUS was seen by a considerable number of observers. Attkins draws it (Fig. 15) as a faint, small, round spot. Phillips shows it elongated E. to W., but also small and faint (Fig. 11). On the other hand, Hall (Fig. 12), Kempthorne (Fig. 13), Molesworth, and Stanley Williams (Fig. 14) agree in drawing it very large and diffuse. Antoniadi: "small and dark (Fig. 16); in-" comparably easier than *Solis Lacus*." On February 17, *Lunæ Lacus* was visible when the *Ganges* appeared diffused, but vanished during the geminated view of this canal.

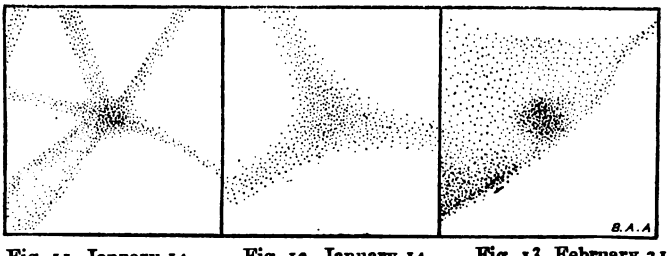

Fig. 11, January 14. (*Phillips.*) Fig. 12, January 14. (*Hall.*) Fig. 13, February 21. (*Kempthorne.*)

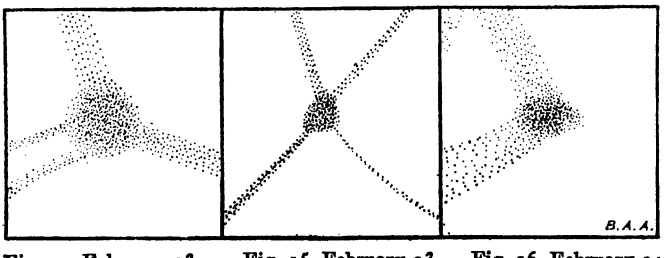

Fig. 14, February 23. (*Stanley Williams.*) Fig. 15, February 23. (*Attkins.*) Fig. 16, February 24. (*Antoniadi.*)

The *Lunæ Lacus* in 1899.

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OPHIR is shown white by Attkins when midway between the centre and the limb, while Corder shades all the country from *Ganges* westwards.

TITHONIUS LACUS.—This is drawn as a small, round spot by Attkins on February 23, and described "as a widening of "*Agathodæmon*." Crowley gives it diffuse (Plate I., 5). Molesworth: double in 1898, July; gemination in round spots. Diameter of the disc at the time, 5″·4. This duplication, however, was not confirmed at the subsequent presentations of this region. The lake was seen, eliptical in shape and "fairly dark," by Phillips (Plate I., 6); faint and diffuse by Antoniadi.

SOLIS LACUS was generally a very faint and difficult feature during the past apparition, so that it was sought in vain by most observers. "Careful search," says Attkins, "under good con-"ditions, on seven consecutive nights, failed to show the slightest "trace of the object." It was also unsuccessfully that Crowley looked for it on February 17. Molesworth, however, although remarking that it was "faint throughout," and that it appeared "more distinct near the edge of the disc than when on the "central meridian," drew it nevertheless as far back as 1898, May 31, when the planet's disc subtended 4″·8 only, having, moreover, reobserved it at all subsequent presentations (Plate II., 1). Less fortunate, Phillips and Antoniadi could scarcely make it out when the planet was near opposition, and his diameter subtended 14″·7.

THAUMASIA was found "very white, nearly equal to polar cap," on March 27, by Attkins, while Molesworth records it as being "very dull, especially to S.E."

AUREA CHERSONESUS is not shown by any of the Members of the Section.*

AONIUS SINUS also has not been seen in 1898–99.†

PHŒNICIS LACUS was found "small, round, and distinct throughout," by Molesworth.

DÆDALIA.—Seen white on limb by Attkins.

THARSIS.—Corder shows this part of the planet shaded, the shading beginning from the *Ganges* and *Nilokeras* in order to extend W.

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* In 1894 the Director found this peninsula missing, and the observations from America and elsewhere gave full support to this view. *Solis Lacus* was thus very near the E. coast of *Thaumasia* (*see* 2nd "Report" of this Section by Mr. Cammell, p. 113). But it is interesting to find that M. Brenner drew, at the time, *Aurea Chersonesus* exactly as found on Schiaparelli's early maps!

† The same remarks apply to this marking, which was replaced since 1892 or 1894 by a nearly bright area. And yet M. Brenner shows it in his 1894 map exactly as Schiaparelli in 1877, viz., a sharp, black bay, long penetrating into the continent N.! That prepossession may go so far as to make one see black what is white will be new to many people. Planets should not be drawn "as they ought to be," but as they are.

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TEMPE was found "extremely white" when central, on January 14, by Phillips—a phenomenon of condensation of some vapour. *Tempe* is often white. In 1864, Kaiser, in his map of the planet's N. hemisphere, showed four protuberances in the outline of the polar cap, the most remarkable of which, extending down to $\Phi = +36°$, was in *Tempe*. Again, in 1879, a white streak seen crossing the *Nilus* by Schiaparelli, was coming from *Tempe*. Lastly, in 1894, the N. polar cap presented a protuberance in *Tempe*, exactly as drawn by Kaiser 30 years previously. Probably, this region is a tableland on which facilitated radiation of heat into space favours condensation.

MÆOTIS PALUS is shown as a faint protuberance to the band encircling the N. polar cap, by Attkins and Antoniadi.

OGYGIS REGIO was seen united by a bridge to *Aromatum Promontorium* by Kempthorne. Attkins and Phillips show this land white on S. limb.

"DIA." *—A land discovered apparently by Dawes in 1864, and called "*Mist Land*" by Proctor in 1888. On February 14, under $\omega = 91°$, Phillips saw the S. limb bright, doubtless owing to the presence of this island on the central meridian, and the same phenomenon was seen by Antoniadi, under $\omega = 101°$, three days later. This island is too far S. to be shown on the Chart. but it can be seen above *Thaumasia* on our 1896–97 map.

NEW LAKE *b*.—$\Omega = 100°$, $\Phi = +29°$; seen by Molesworth and Phillips somewhere on *Ceraunius;* and an intensification of *Ceraunius* there where it meets Lowell's "*Gigas*"; probably double.

CANALS.

AGATHODÆMON.—Seen by Attkins: very narrow.—Crowley: very diffuse —Molesworth: diffuse.—Phillips: narrow; "not difficult by any means."

CERAUNIUS.—Attkins: single, though "faint and broad."—Molesworth: double, bands diffuse.—Phillips: broad, "seen broad in moments of comparative steadiness."—Antoniadi: anomalously double, as in Schiaparelli's charts; both bands very faint and diffuse. [Intensifications of *Ceraunius* there where it is met by other canals, are shown by Molesworth and Phillips.]

CHRYSORRHOAS.—Attkins: narrow.—Kempthorne: narrow.—Molesworth: diffuse.—Phillips: moderately broad.

CLARIUS.—Attkins, Molesworth, Phillips, and Antoniadi, all agree in showing this canal as part of the polar band.

EOSPHOROS.—Drawn by Molesworth: diffuse.

GANGES.—Attkins: usually narrow, but "very broad," February 17.—Corder: very diffuse.—Hall: very diffuse.—Kempthorne: not indicated; a vague shading covering the triangular region *Ganges—Iamuna—Nilokeras.*—Molesworth: double, 1898, April 27, with a disc of Mars not greater than 4″·6; sharply double, October 27.—Phillips: broad; "less prominent than in 1896–97."—Stanley Williams: "broad, but faint and diffuse."—Antoniadi:

* Name given by the Director. Δία was the old name of Naxos; also that of an island a few miles N. of Crete.

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usually broad and diffuse; but on February 17^{d} 8^{h} 23^{m} distinctly double (Fig. 17) with *Nilus*. (*See* "Journal," Vol. IX., p. 371.) The appearance lasted for about one third of a second. The planet's limb appeared, mean-

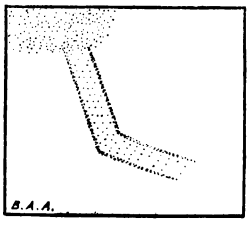

Fig. 17. Gemination of the *Ganges* and *Nilus*, as seen for one third of a second, on 1899, February 17 (*Antoniadi.*)

time diffuse. But this does not invalidate the idea of objective gemination, inasmuch as the eye cannot, at a given moment, see distinctly over more than a very small fraction of the planet's disc. It will be seen that in this case the broad and diffuse appearance given to the *Ganges* by other observers corresponds very satisfactorily to an imperfect view of the two lines, the distance separating which is practically equal to the breadth of the broad band. If we consider, moreover, that Capt. Molesworth and Signor Cerulli have also seen the *Ganges* doubled, we think that there can be little doubt of the objective reality of this gemination, and that the fugitive appearance seen on February 17, was, as suspected at the time by the Director, a neater perception of the amorphous *Ganges* seen under unfavourable definition.

Attkins saw an indentation in *Auroræ Sinus* at the estuary of the *Ganges*.

FORTUNA.—Molesworth and Phillips: diffuse.

IRIS.—Seen by Phillips: diffuse.

ISSEDON was seen by Molesworth diffuse, when the planet's disc measured 5″·7.

NECTAR.—Molesworth: diffuse; "usually fairly easy." There is a prolongation of *Nectar* into the *Mare Erythræum*.—Phillips: diffuse.

NILUS.—Attkins: narrow and faint.—Hall: broad and diffuse.—Molesworth: diffuse.—Phillips: "not difficult . . . seen to terminate in a dusky spot on *Ceraunius*. It was less broad than the *Ganges*, but was *not* seen as a narrow, sharply defined line."—Stanley Williams: "broad, very faint, diffuse."—Antoniadi: distinctly double on February 17. The breadth separating] the two streaks was equal to that of the faint line seen by Stanley Williams. Hence the probable objectivity of this doubling also.

PHASIS.—Crowley: indefinite.—Molesworth: diffuse.

PHLEGETHON.—Molesworth: diffuse; seen on 1899, July 6, on a disc of 5″·0.—Phillips: faint and moderately narrow.—Antoniadi: easy; dark and narrow streak, on January 8.

TANAIS.—Seen by Attkins, Brown, Molesworth, Phillips, Stanley Williams, and Antoniadi, as part of the dark boundary of the N. cap.

URANIUS.—Seen by Kempthorne: narrow.

NEW CANAL, A.—From $\Omega = 42°$, $\Phi = +43°$, to $\Omega = 98°$, $\Phi = +30°$. Detected by Molesworth. ← ALANDER,

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SECTION IV.

Mare Sirenum.

$\Omega = 120°$ to $180°$; $\Phi = +60°$ to $-60°$.

ICARIA.—Owing to the invisibility of *Aonius Sinus* (p. 85) this land was not defined to the S.E. On the other side, however, to the N.W., along *Mare Sirenum*, the coast did not seem to have undergone any appreciable change since former years. Attkins, Molesworth, Phillips, and Antoniadi agree on this point. Attkins saw *Icaria* white near the limb.

PHAETHONTIS is described as a "brilliant white spot on limb," March 14, by Attkins. Phillips says that it was "very brilliant, appearing at times to indent the *Mare Sirenum*." A. A. Williams and Antoniadi also show it white near the limb.

MARE SIRENUM.—Attkins, Crowley, Molesworth, and Phillips (Plate II., 3) give to this marking its usual Schiaparelli outline. Attkins shows it fairly dark, and so also Kempthorne, particularly towards *Titanum Sinus*. "The beak of the *Sirens*," says Molesworth, "remained fairly dark throughout." (Plate II., 2.) The same observer noted, on 1898, October 17, "a delicate blue grey, the blue tinge being most obvious at *Titanum Sinus*." Phillips found this *Mare* rather faint, probably fainter than in 1896–97. The estuary of the canal *Gorgon* was seen as a dark knot by Molesworth.

ATLANTIS I. is shown as a bright bridge by Attkins ("plain"), Brown (marked near limb), Kempthorne (very marked indeed), Molesworth ("fairly distinct at times, most distinct near terminator"), Phillips ("distinctly seen in moments of best image"); and Antoniadi (slightly shaded).

ATLANTIS II.—Not shown by any of the Members of the Section.

MEMNONIA was seen white near the limb by Attkins.

AMAZONIS.—"Duller than *Memnonia* or *Zephyria*" (Molesworth).

ARCADIA does not seem to have shown any shading in 1898–99.

NODUS GORDII is drawn as a large, faint, round marking by Attkins. Hall shows it very diffuse, very faint, and very extended. Molesworth: "diffuse, but having, when the defini- "tion was first-class, a streaky aspect, as if including numerous "faint canals." Phillips shows it also exceedingly diffuse.

"NODUS GORDII" (Lowell*).—This small "bead" on *Eumenides-Orcus* was seen by Molesworth.

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* For the differentiation between the two *Nodi*, *see ante*, p. 72.

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"LUCUS MARICÆ" (Lowell). — Seen by Molesworth and Phillips.

"AMMONIUM" (Lowell).—Seen by Molesworth and Phillips.

"CASTALIA FONS" (Lowell).—Seen by Molesworth.

PROPONTIS.—This large lake is shown on the drawings of a considerable number of Members of the Section. Hall draws it very accurately, and not quite separated from the polar "marshes." It is dark on Kempthorne's drawing. Killip shows it vaguely.

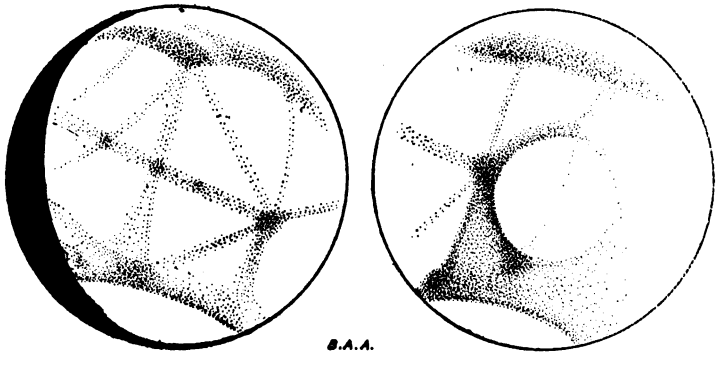

Fig. 18, 1898, Oct. 17. (*Molesworth.*)

Fig. 19, 1899, Feb. 1. (*Phillips.*)

Recent views of the *Propontis* region of Mars.

Antoniadi found it vague and diffuse. Molesworth and Phillips depict *Propontis* so beautifully that we subjoin their whole disc drawings of these regions (Figs. 18 and 19). "This lake," says Phillips, "was quite dark, even when close to the terminator."

NEW LAKES:—

c $\Omega = 122°, \Phi = -\ 9°$; detected by Molesworth.
d $\Omega = 167°, \Phi = +\ 28°$; detected by Molesworth.

CANALS.

"BRONTES" (Lowell).—Seen by Molesworth, diffuse.

"ELISON" (Lowell).—Seen by Molesworth, diffuse.

EUMENIDES-ORCUS.—Atkins: narrow.—Corder: very diffuse.—Hall: diffuse.—Kempthorne: narrow.—Molesworth: diffuse, broad; S. edge distinct; N. diffuse. Inasmuch as this observer notes *Amazonis* duller than *Memnonia*, the canal *Eumenides-Orcus* becomes the edge of a shade.—Phillips: "not so dark as during last apparition" (Dec. 31)—"*Orcus* seen "as a faint, broad streak, but no lakes on it" (January 4). "Seemed darker than of late," (February 21). "On one occasion," says Phillips, "the *Eumenides-Orcus* was for a moment or two doubled, together with the "*Trivium Charontis*. The effect, however, was very transitory, and was "evidently an optical illusion caused, perhaps, by the passing of air-waves "or by a temporary alteration of the focus of the eye."—Stanley Williams: "seemed single."—Antoniadi: broad and indefinite.

EUROTAS.—Seen by Molesworth, diffuse.

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FEVOS.—Seen by Molesworth, diffuse.

GIGAS.—Hall: very indefinite.—Molesworth: directed on drawings more N., possibly Lowell's "*Gigas*" and not Schiaparelli's. The change of direction is a frequent phenomenon with canals, according to Schiaparelli.

GORGON.—Molesworth: diffuse.—Antoniadi: confuse; at one time a very hazy impression of doubling; doubtful.

HEBRUS.—Seen by Molesworth, diffuse.

PYRIPHLEGETHON.—Attkins: narrow.—Killip: harsh; moderately broad.—Molesworth: diffuse.—Phillips: diffuse.

SIRENIUS.—Attkins: narrow.—Killip: harsh; moderately broad.—Molesworth: diffuse.—Phillips: very broad to N.

TITAN.—Hall: diffuse.—Molesworth: diffuse.—Phillips: diffuse.

NEW CANAL B.—From $\Omega = 106°$, $\Phi = +30°$ to $\Omega = 150°$, $\Phi = +20°$; detected by Molesworth. ← CHARADRUS.

SECTION V.

Mare Cimmerium, Elysium, and Trivium Charontis.

$\Omega = 180°$ to $250°$; $\Phi = +60°$ to $-60°$.

MARE CIMMERIUM.—This long sea was seen by most Members with its customary outline, and the descriptions of its intensity are fairly accordant: *Mare Cimmerium* was moderately dark in 1898–99. Attkins, Brown, Corder, Crowley, Hall, A. A. Williams and Antoniadi confirm each other here. However, Killip, Mee, and Phillips depict this area a little darker and narrower than on Schiaparelli's maps. Phillips adds: "strange to say, the *Mare* "*Cimmerium* has appeared to me considerably darker than *Mare* "*Sirenum*. Exactly the reverse was the case last apparition." Kempthorne shows it a little darker still, while Molesworth found the colour of the *Mare* "dark bluish grey. Only traces of "*Cimmeria* have been seen between *Sinus Læstrygonum* and "*Cyclops*."

HESPERIA is drawn exceedingly narrow by Attkins, who describes it "distinct." Corder saw it very bright, but apparently severed from the land to the N. Hall: "so faint as to be doubtful," February 2. Kempthorne shows it shaded, February 3. Mee depicts it distinctly white, and, like Corder, severed from the mainland (*Triton*). Molesworth remarked that the N. portion of this peninsula was shaded. Phillips: "well seen," December 23, "*Hesperia* narrow, but very distinct," but on March 7 "no trace of *Hesperia*, though carefully looked for." The peninsula is further distinctly drawn by A. A. Williams (Plate III., 2). Antoniadi found nothing abnormal in these regions. The plurality of inclined peninsulæ or islands bending round at right angles to join the mainland to the N. is a striking feature of the planet's S. hemisphere. *Pyrrhæ Regio*, *Deucalionis Regio*, *Œnotria*, *Hesperia* and, perhaps, *Atlantis*, all present more than one point of similitude.

TYRRHENUM MARE (E.).—Attkins depicts this sea of the same tone as the *Mare Cimmerium*; Corder, less dark. So also

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Molesworth, A. A. Williams, and Antoniadi; Mee and Phillips show it very dark; Kempthorne, still darker.

ELECTRIS has been drawn white on the limb by Molesworth, Phillips, and Antoniadi. Phillips says that it was "very white at the terminator;" also very white on S. limb, December 31.

ERIDANIA is described "as white as polar cap," March 14, by Attkins. Molesworth also shows it white. Phillips notes it "very white at the terminator." *Eridania* was invariably bright on the limb to Antoniadi.

ZEPHYRIA is shown white at the edge of the disc by Attkins and Phillips.

ÆOLIS was seen white near the limb by Attkins.

ÆTHIOPIS is represented slightly shaded by Kempthorne.

"PAMBOTIS LACUS" (Cerulli), on the rendezvous of *Cyclops*, *Cerberus*, *Antæus*, *Pactolus*, and *Eunostos* was admirably seen by Brown and Molesworth.

ELYSIUM appears to be the brightest continental area of the planet; its brightness being not only remarkable when rising or setting at the edge of the disc, but remaining considerable even when the rotation of Mars brings it over the central meridian. The correct polygonal outline of this marking is shown by almost all the Members:—Attkins, Brown, Corder, Hall, Kempthorne, Mee, Molesworth, Phillips, Stanley Williams, and Antoniadi. The latter found the canals bounding this area sharp inside, diffuse outside. As in 1896–97, the brightest part of *Elysium* was its E. angle. At this point an intensely white spot was drawn by Attkins, Brown, Kempthorne, Molesworth, Phillips, and Antoniadi. Phillips, moreover, draws all the E. half of *Elysium* brighter than the W. half; the line of demarcation between the two tints being the *Galaxias*. Brown confirms this; but, inasmuch, as he sees the polygon cut into three (Plate II., 6) by the new canal **C** as well as by the curved line discovered in 1896 by Molesworth, his W. boundary of the bright area is different from that of Phillips. Molesworth gives a smaller surface to the bright patch; he again saw *Elysium* broken up by his 1896 canal (**E** on our last chart), and seems to have also detected part of *Galaxias*. The brightness of Elysium would seem to have decreased with the shrinking of the disc. On March 10, Attkins found the white spot invisible, a statement which received full corroboration at the hands of Phillips and Antoniadi. The change, however, might not necessarily be objective, the increasing distance of Mars having, perhaps, something to do with it.

TRIVIUM CHARONTIS.—This remarkable dark spot was described by Attkins as "oblong in shape, running, roughly, N. and S. (Plate II., 5); darker than seas; *f* side very dark and definite, *p* indefinite," and, lastly, "crescentic" on March 14. On March 15, the same observer found that "*Trivium Charontis* seemed to be nearly "divided by the white spot following it." Brown notes that the lake seemed composed of "two very dark markings," which he could not see round. Corder and Crowley show the spot very diffuse, and in this they are confirmed by Hall,

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who, however, draws it darker at the S.W. end. Kempthorne shows it as a black equilateral triangle, one point of which is directed towards the *Orcus*, the other towards the *Cerberus*, and the last one along the *Styx*. Stanley Williams corroborates this statement: "*Trivium Charontis* itself," he says, "is not double "at the present time, but seems of a triangular shape, with "lighter interior, as though it were formed by several crossing or "interlacing canals, as represented in the diagram." (Fig. 20.)*

Fig. 20.—The *Trivium Charontis* in March 1899.
(*Stanley Williams.*)

Molesworth, Phillips, and Antoniadi show the lake dark in the centre, but with diffused edges, whilst A. A. Williams gives it a remarkable extension.

HEPHÆSTUS is shown as a very faint and diffuse marking by Brown, Hall, Molesworth, and Phillips. The latter depicts it as the S.E. boundary of the great shading near *Boreosyrtis*.

HECATES LACUS.—A dark spot on the N.E. angle of *Elysium*, at the meeting point of *Styx*, *Chaos*, *Plutus*, *Boreas*, and *Æsacus*; seen by Brown (very dark), Molesworth, Phillips (very dark), and Antoniadi.

STYMPHALIUS LACUS.—This is the name given by Schiaparelli, in 1888, to the dusky area at the rendezvous of *Æsacus*, *Granicus*, *Choaspes*, *Adonis*, and *Gyndes*. The marking is shown by Brown and Phillips ("large dark lake between *Styx* and *Hades*," December 29).

PHLEGRA.—Shown shaded by Corder, Kempthorne, Molesworth, Phillips (Plate II., 4), and Antoniadi.

CEBRENIA.—Shaded: Corder, Mee, Molesworth, Phillips, and Antoniadi.

ÆTHERIA. — Shaded: Corder, Kempthorne, Molesworth, Phillips, and Antoniadi.

It would appear that the shading of these regions was an extension of the great *Boreosyrtis* intensification, dealt with in the next Section.

NEW LAKES:—

e $\Omega = 217°$, $\Phi = +39°$; detected by Brown.
f $\Omega = 225°$, $\Phi = +39°$; detected by Brown.

* Mr. Stanley Williams remarks that "an intensification of two such spots "at the N. and S. angles of the triangle might cause the *Trivium Charontis* "to appear under the form of two round black spots," as seen in 1896.

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CANALS.

ADAMAS.—This is the name given by Schiaparelli to a double canal observed by him in 1888 uniting *Boreosyrtis* to *Hephæstus*. The same canal, but single, and continued to *Mare Cimmerium* ("*Pseudoæthiops*" of Signor Cerulli), was observed by the following Members of the Section in 1898–99:—Kempthorne: single, narrow, "clear and sharp."—Molesworth: single, diffuse (not following the same course as Kempthorne's line).—Antoniadi: single, easy, and narrow.

ÆSACUS.—Brown: diffuse.—Molesworth: seen on 1899, June 26; D = 5″·2.—Antoniadi: diffuse.

ÆTHIOPS.—Seen by Molesworth only: diffuse.

ANTÆUS.—Seen by Kempthorne: narrow.—Molesworth: diffuse.

BOREAS.—Seen by Molesworth only: diffuse.

CERBERUS.—Attkins: rather narrow.—Brown: broad and marked.—Corder: diffuse.—Hall: faint, diffuse.—Kempthorne: rather narrow.—Killip: broad, harsh.—Mee: diffuse.—Molesworth: double, on 1898, November 17; gemination extending to *Cyclops*, after which the canal is single to *Mare Cimmerium*.—Phillips: exceedingly broad; "surely it is a quite "misnomer to speak of the *Cerberus* as a '*canal*.' I think it would be more "correct to term it a '*sea*,' if, indeed, the broad dark areas are aquatic "at all."—Stanley Williams: double. On March 15, "definition was pretty "good at times, and the canal appeared most distinctly double with 450. "Owing to the small size of the image (apparent diameter of planet = 10″); "the duplicity was only suspected with 320, but with the higher power "it was undoubted. The canal, in fact, was seen double with as much "certainty and distinctness as a double star near the limit of separation for "the aperture employed."—Antoniadi: very broad and dark; as dark, indeed, as *Mare Cimmerium*.

CHAOS.—Brown: diffuse.—Corder: diffuse.—Hall: indefinite.—Molesworth: diffuse.—Phillips: dark and broad.—Antoniadi: very marked.

CYCLOPS.—Attkins: narrow.—Brown: very narrow.—Corder: very broad.—Kempthorne: edge of shading on Æthiopis.—Molesworth: at first diffuse, but then double, 1898, November 17.—Phillips: "broad"; inclined to meridian; trend from N.N.E. to S.S.W., February 1.—Stanley Williams: diffuse.—Antoniadi: very faint, difficult, and diffuse.

EREBUS.—Attkins: narrow.—Molesworth: diffuse.—Phillips: faint.

EUNOSTOS.—Attkins: narrow.—Brown: narrow; then, possibly, anomalously double?—Corder: diffuse.—Kempthorne: broad, diffused.—Mee: diffuse.—Molesworth: diffuse.—Phillips: moderately broad.—Stanley Williams: broad.—Antoniadi: diffuse, but very easy.

GALAXIAS.—Brown: narrow.—Phillips: extremely narrow.

GRANICUS.*—Seen by Brown: diffuse.

GYNDES.—Seen by Brown: diffuse.

HADES.—Hall: faint, diffuse.—Kempthorne: broad; edge of shading between it and *Styx*.—Killip: harsh and broad.—Molesworth: diffuse; edge of shading between it and *Styx*.—Phillips: dark; edge of shading between it and *Styx*.—Stanley Williams: well marked; "suspected double."—Antoniadi: diffuse; edge of shading between it and *Styx*.

HYBLÆUS.—Brown: broad.—Corder: diffuse.—Molesworth: diffuse.—Phillips: moderately broad.—Antoniadi: obvious, but diffuse.

"HYBLÆUS II." (Molesworth).—Seen by Brown and Molesworth in about the same position as drawn by the latter in 1896–97. This is the canal E. of our last chart. Diffuse and curved.

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* Prof. Schiaparelli draws attention to the fact that in his map, published in 1889 in "Himmel und Erde" (Flammarion, "Mars," p. 440), the *Granicus* is erroneously called *Gyndes*, and that the name for the true *Gyndes* is missing. The *Granicus* unites *Propontis* to *Stymphalius Lacus*; the *Gyndes*, *Stymphalius Lacus* to *Sithonius Lacus*.

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LÆSTRYGON. — Brown: narrow. — Kempthorne: narrow. — Molesworth: diffuse.— Phillips: narrow.—Antoniadi: narrow and difficult.

PACTOLUS.—Seen by Brown: narrow.—Molesworth: diffuse.

PLUTUS.—Brown: diffuse.—Molesworth: diffuse; seen on a disc of 5″·2. The angular breadth of the canal ought not thus to have exceeded $\frac{1}{10}$″.

STYX.—Brown: dark and very broad.—Corder: exceedingly broad, melting into shading towards *Hades*.—Kempthorne: broad; edge of shading between it and *Hades*.—Killip: broad.—Mee: diffuse.—Molesworth: double; 1898, November 9, space between it and *Hades* shaded.—Phillips: almost black; space between it and *Hades* shaded.—Stanley Williams: broad to N., narrow to S.; this makes it triangular in appearance.—Antoniadi: very dark and broad; double (?) February 4; edge of shading between it and *Hades*.

TARTARUS. — Kempthorne: narrow. — Molesworth: diffuse. — Stanley Williams: diffuse.—Antoniadi: very faint and diffuse.

TRITON.—Corder: broad and black.—Mee: harsh and black.—Molesworth: diffuse.

XANTHUS.—Drawn by Molesworth early in 1898, when the planet showed us its S. pole.

NEW CANAL, C.—From $\Omega = 220°$, $\Phi = +19°$, to $\Omega = 232°$, $\Phi = +14°$. Detected by Brown.

SECTION VI.

Syrtis Major.

$\Omega = 250°$ to $310°$; $\Phi = +60°$ to $-60°$.

TYRRHENUM MARE (W.).—This, the W. portion of *Mare Tyrrhenum*, was much darker than the E. portion. It has been seen quite dark up to the limb.

SYRTIS PARVA did not present any remarkable features. It was not a very dark marking. Kempthorne shows it of the same tint as *Maria Cimmerium* and *Tyrrhenum*, and somewhat harshly marked. Mee, Molesworth, and Phillips corroborate this view. On the other hand, however, Brown, Corder, Hall, A. A. Williams, and Antoniadi agree in showing it a little fainter and somewhat more confused.

AUSONIA.—Seen white near S. limb by Hall, Mee, Phillips, and Antoniadi. The whitening does not seem to have been very intense. Townshend saw, in addition, a bluish tinge to the white colour of this ill-defined land.

HADRIACUM MARE is shown dark by Attkins, and very dark by Corder. Molesworth also draws it very dark, and with a darker knot on the W. coast of *Hellas*, somewhere about the *f* embouchure of *Peneus*. Phillips and Antoniadi draw it fainter. Only the lower half of the boundary of *Hellas* was well seen in 1898–99.

HELLAS.—Owing to the tilt of the axis, this land was never orange red when on the central meridian. On March 9, Attkins found it "nearly as white as polar cap."* Also, Hall, Mee,

* *Hellas* has often been mistaken for a polar cap. Thus, on 1777, April 17, Sir William Herschel drew two caps, one N. the other S., the line uniting which, however, did not pass through the centre of the planet's disc (Flammarion, "Mars," p. 51, Fig. 17 of Herschel's series). The longitude of the centre was 324° and its latitude positive. Hence there can be no doubt that "cap *a*" was not a true cap, but white *Hellas* on S. limb.

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Molesworth, Phillips, Townshend (Plate III., 3), and Antoniadi insist on its remarkable brightness.

"LUNÆ PONS" (Lowell) is represented by Attkins ("very distinct"), Brown, Hall (Plate III., 1), Phillips, Molesworth, and Antoniadi.

"SOLIS PONS" (Lowell) is shown by Attkins, Hall, Molesworth, Phillips, and Antoniadi.

IAPYGIA is indicated by Brown; it was seen by Hall, and described "very distinct" by Phillips.

ŒNOTRIA.—An easier marking than the preceding. Attkins shows it disfiguring *Syrtis Major* by transforming into a "shoal" a considerable part of its W. half; the shoal seeming bounded to E. by a strong black line.* Brown and A. A. Williams depict it as a slight fading of the *Syrtis*. Kempthorne gives it an E. extension—almost near *Mœris Lacus*, while Molesworth, Phillips, and Antoniadi saw it as given in Schiaparelli's charts.

SYRTIS MAIOR.—No important change in the general outline of this grand object since 1896–97. As at the last apparition, the *Syrtis* showed very decidedly the form given to it by Lowell in 1894, with a sharp point to the N. The numerous drawings by Attkins, Brown, Corder, Hall, Kempthorne, Killip, Mee, Phillips, Townshend, A. A. Williams, and Antoniadi are all in excellent agreement as to this. But Molesworth shows the N. end distinctly blunted, as on the annexed diagram (Fig. 21). A very large

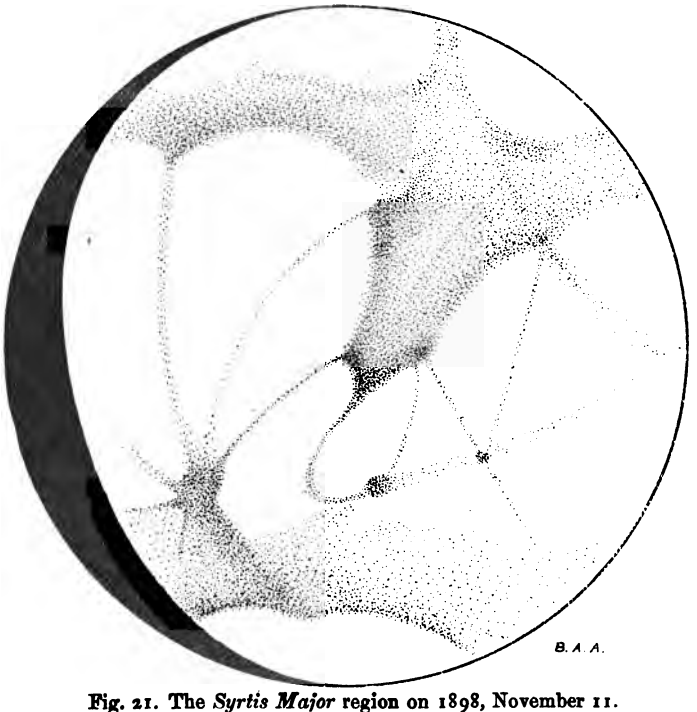

Fig. 21. The *Syrtis Major* region on 1898, November 11. (*Molesworth.*)

* Probably Lowell's "*Dosaron.*" This canal in a dark area is shown on Prof. Schiaparelli's drawings in 1888.

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majority of the drawings sent show further the N. end as the darkest part of the *Syrtis*. The colouring of this immense dark area did not seem uniform. Allusion has already been made to Attkins's remarkable observation of what seems to be Lowell's "*Dosaron*," vague traces of which are found on the Ceylon drawings, but in his description of Fig. 21, Molesworth draws attention to the "much veined" appearance of *Syrtis Major*, which was "very dark and distinct, with darker nuclei at the "estuaries of *Typhon*, *Thoth*, *Astapus*, and *Astusapes*." Colour: "a distinctly greenish grey" (Molesworth). According to the same observer, the "following side of *Syrtis Major* was very dark —more so than the preceding side." Townshend lays stress on the fact that the duplication of the N. point observed by him in 1896–97 (*vide* last "Report," p. 94) had been confirmed by M. Comas Sola in Spain. On one of his drawings A. A. Williams unites *Libya* to *Hammonis Cornu* by a straight bridge, parallel to the Martian equator, and recalling to memory a drawing taken by Mr. Gledhill on 1871, April 4 (Flammarion, "Mars," p. 208, Fig. 129), and Lohse, 1873, May 25 (*Ibid.*, p. 227, Fig. 146).

As in 1896–97, Phillips was fortunate in detecting a bright bridge in $\Phi = +22^\circ$ completely separating the *Syrtis Major* from the *Nilosyrtis* (Fig. 22). "I have noticed this," he says, "distinctly on several occasions when the air had been good enough, "and feel quite convinced of its objective existence." Attkins fully endorsed this statement when saying that on March 10,

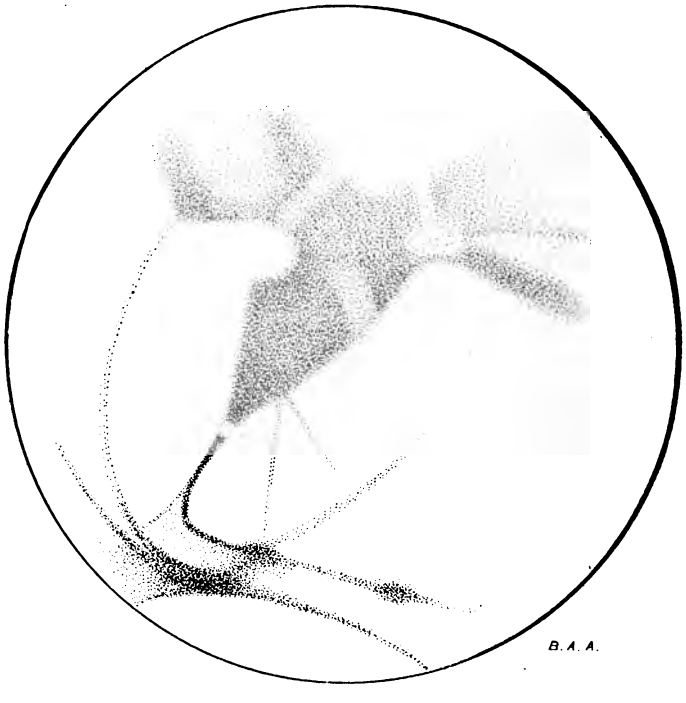

Fig. 22. Bridge severing the *Syrtis Major* from the *Nilosyrtis*. 1899, January 30. (*Phillips*).

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" at times it appeared that *Syrtis Major* was separated from " *Nilosyrtis* by a whitish marking—probably owing to irradiation " from a whitish, round spot following N. end of *Syrtis Major*" —an observation which he repeated on April 11.* This occasional bridging of the *Maria* is not a rare occurrence on Mars. In 1890 it was *Solis Lacus* which was thus cut in two, in 1892 *Mare Sirenum* (near the " beak "), according to Schiaparelli; while the narrow white marking seen by the Flagstaff observers in 1894 to issue from *Fastigium Aryn* southwards, across *Dawes's Forked Bay*, probably belongs to the same class of phenomena.

MŒRIS LACUS is shown as a mere bight of the *Syrtis Major* by Attkins, Brown, Mee (Plate III., 4), Molesworth (" still merged in the eastern coast of the *Syrtis Major* "), Phillips, Stanley Williams, and Antoniadi. On February 1, however, Phillips saw a faint lake a short distance inland, E. of *Mœris*, while Stanley Williams notes that " *Lacus Mœris* appeared as a round, " very dark, in fact, almost black-looking spot, open on the " following side to the *Syrtis Major*, though once or twice a " narrow bright border separating it from the latter was " suspected."†

LIBYA.—Observed bright by all the Members of the Section, and further brightening near the terminator or limb. Comparing the observations of 1888 or 1890 with those of 1898–99, it will be found, in spite of some recent statements to the contrary, that the evidence of objective change is overwhelming, and that the results are here far outside the errors of observation.

NIX ATLANTICA.—On a drawing dated 1898, November 9, $\omega = 276°, \overset{\circ}{\Delta}\phi = +16°$, Molesworth depicts a small, bright round spot very near the position of the celebrated *Nix Atlantica*, seen by Prof. Schiaparelli from 1877 to 1882. In his description of this marking, the observer simply notes " a small circular bright " spot, apparently just N. of the estuary of Thoth." But there can be little doubt of its identity with *Nix Atlantica*. " If its appearance," wrote Schiaparelli in 1888 (Flammarion, " Mars," p. 441), depend on the period of the Martian seasons, we ought to expect to re-observe it during the oppositions of 1892 to 1897, and it is easy to appreciate of what importance will be its return for the study of the physical constitution of the planet."

NEITH REGIO is shown slightly shaded between the canals *Nilosyrtis* and " *Nasamon*," by Attkins, Corder, Phillips, A. A. Williams, and Antoniadi. This completes the " hour-glass " form of *Syrtis Major*. A bright spot was seen by Kempthorne in *Neith Regio* towards $\Omega = 268°$, $\Phi = +34°$.

COLOE PALUS is well depicted by Brown, as a very small black spot, January 26. Kempthorne, Molesworth, Phillips, and Antoniadi, give it a more diffused appearance.

UTOPIA.—This bright continental area was transformed, in 1898–99, into a very dark, almost black, marking, the blackness

* Signor Cerulli further confirms the reality of this marking in his 1898–99 map.

† The laky character of *Mœris* is clearly shown by Cerulli.

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remaining unchanged even when rotation brought it on the limb. Atkins, Corder, Hall, Kempthorne, Mee, Molesworth, Phillips, and Antoniadi, thus show the country marked by an extraordinary mass of dark material. The latter would seem to be furnished by the intensification of the great canal *Boreosyrtis*, and it is probable that the partial concomitant shading of *Ætheria*, *Cebrenia*, and *Phlegra*, described in Section V., was due to the same cause. In this case also, the evidence in favour of objective change since 1888 is very strong.*

NEW LAKES:—

g $\Omega = 262°$, $\Phi = +34°$; detected independently by Brown and Kempthorne.

h $\Omega = 280°$, $\Phi = +54°$; detected by Phillips in 1896–97

(when the canal *Boreosyrtis* was seen "swollen into a lake-like aspect," *vide* last Report, p. 94); and re-observed now by Atkins, Brown, Corder, Hall, Kempthorne, Mee, Molesworth, Phillips, and Antoniadi.

CANALS.

ALCYONIUS.—Seen by Molesworth on 1899, June 21, D = 5″·2.

AMENTHES.—Atkins: very narrow.—Brown: faint.—Kempthorne: very narrow; edge of shading in *Æthiopis*.—Mee: diffuse.—Molesworth: diffuse.—Phillips: moderately broad.—Stanley Williams: faint.—Antoniadi: very easy, though broad and diffuse.

ANUBIS.—Seen by Molesworth diffuse.

ASCLEPIUS.—Mee: in part only.—Molesworth: diffuse.—Antoniadi: faint and diffuse.

ASTABORAS.—Molesworth: diffuse.—Phillips: narrow.

ASTAPUS.—Brown: narrow.—Kempthorne: very narrow.—Molesworth: diffuse.

ASTUSAPES.—Brown: narrow.—Molesworth: diffuse.—Phillips: very narrow.

ATHYR.—Seen by Molesworth diffuse.

"AXON" (Cerulli).—Molesworth: diffuse and extending E. and W. of Cerulli's "*Nuba*."—Antoniadi: diffuse and broad.

BOREOSYRTIS.—Attkins: very dark; darker than *Mare Cimmerium*, March 14, W. limit of shade in *Utopia*.—Brown: broad.—Corder: diffuse.—Hall: dark and broad.—Kempthorne: extremely dark and definite; W. end of *Utopia* shade.—Mee: very dark; W. limit of *Utopia* shade.—Molesworth: very dark.—Phillips: exceedingly dark; W. limit of shade in *Utopia*.—Antoniadi: dark and broad; W. limit of shade in *Utopia*.

EURIPUS.—Seen by Molesworth diffuse.

HELICONIUS.—Seen by Molesworth; diffuse on a disc of 5″·2.

LETHES.—Seen by Antoniadi very faint.

"NASAMON."†—Attkins: narrow.—Hall: diffuse.—Molesworth: diffuse.—Phillips: faint; edge of shading in *Neith Regio*.—Townshend: diffuse.—

* The darkness of the *Boreosyrtis* region has been detected long ago. It is shown on drawings by Hooke, 1666; W. Herschel, 1777; De la Rue, 1856; Secchi, 1858; Burton, 1871; Flammarion, Green, Lohse, Schmidt, and Terby, 1873; Burton, 1882; Knobel and Lohse, 1884; Denning, 1886; Perrotin and Wislicenus, 1888, &c. It is, meantime, interesting to point out that whereas the last two observers were seeing shaded the region in question in 1888, Schiaparelli did not see any shading at all.

† *See* p. 70.

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A. A. Williams: diffuse; edge of shading in *Neith Regio*.—Antoniadi: diffuse; edge of shading in *Neith Regio*.

NEPENTHES.—Kempthorne: "very faint"; narrow.—Molesworth: almost straight from *Mœris Lacus* to *Hephæstus*; diffuse.—Phillips: narrow.—Antoniadi: faint, not in its Schiaparellian course.

NILOSYRTIS.—Attkins: narrow.—Brown: narrow, dark.—Corder: diffuse.—Kempthorne: very narrow, gracefully curved.—Killip: narrow.—Molesworth: narrow.—Phillips: narrow and dark; edge of shade in *Neith Regio*.—A. A. Williams: diffuse, edge of shade in *Neith Regio*.—Stanley Williams: "remarkable for its faintness in March."—Antoniadi: difficult. Certainly not the easiest of canals in 1898–99.

"RHESUS" (Cerulli).—Seen by Molesworth diffuse.

THOTH.—Brown: faint.—Antoniadi: indefinite.

SECTION VII.

The South Polar Region.

$\Omega = 0°$ to $360°$; $\Phi = -60°$ to $-90°$.

Mars was too far from the earth when the south polar cap was visible, early in 1898. Hence, no returns of the diminution of the white material came to hand, with the exception of the following Table, due to Molesworth, and in which ω is the longitude of the centre of the disc during observation, α the areocentric arc subtended by the cap, and d the number of days separating the determination from the summer solstice of the S. hemisphere (— before, + after):—

Date.	ω	α	d.	Date.	ω	α	d.
1898.	°	°		1898.	°	°	
April 25 -	86	42	−36	June 8 -	357	17	+ 8
„ 27 -	63	42	−34	„ 9 -	348	17	+ 9
May 1 -	27	41	−30	„ 11 -	332	13	+11
„ 3 -	4	38	−28	„ 17 -	270	11	+17
„ 7 -	325	34	−24	„ 18 -	263	11	+18
„ 8 -	317	32	−23	„ 21	233	invis.	+21
„ 11 -	289	28	−20	„ 25 -	194	invis.	+25
„ 12 -	272	29	−19	„ 26 -	187	10	+26
„ 13 -	265	28	−18	„ 27 -	170	9	+27
„ 16 -	232	26	−15	„ 29 -	151	11	+29
„ 18 -	216	27	−13	„ 30 -	148	9	+30
„ 20 -	196	26	−11	July 1 -	131	10	+31
„ 21 -	184	26	−10	„ 2 -	118	7	+32
„ 23 -	164	24	− 8	„ 3 -	118	invis.	+33
„ 24 -	149	24	− 7	„ 4 -	105	invis.	+34
„ 25 -	143	22	− 6	„ 6 -	85	8	+36
„ 31 -	80	20	0	„ 7 -	71	9	+37
June 1 -	72	19	+ 1	„ 9	54	6	+39
„ 2 -	60	20	+ 2	„ 10 -	44	invis.	+40
„ 4 -	37	20	+ 4	„ 11 -	38	9	+41
„ 5 -	38	17	+ 5	„ 12 -	28	invis.	+42

After July 11, the S. cap was seen no more in Ceylon. Soon after its disappearance, whitish glimmers were visible in the S. polar regions, as in 1896–97.

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SECTION VIII.

The North Polar Region.

$\Omega = 0°$ to $360°$; $\Phi = +60°$ to $+90°$.

"Throughout August and September, the N. polar region was "generally a dull white, with none of the characteristics of a true "polar cap. . . . . Towards the middle of September this "became a dull, not very white, patch, bounded, as a rule, by a "very faint streak of shade, diffuse towards the S. It was not "till September 28, that the cap was really well seen, shining "with a pale, almost greenish lustre, brightest to E., the bounding "marsh being distinct and dark" (Molesworth). Traces of the cap were also caught by Phillips on 1898, September 16, and by Stanley Williams a week later.

The change in the area of the white material went on as follows:—

d is here the number of days before (−) or after (+), the summer solstice of N. hemisphere.

Date.	ω	α	*d*	Observer.	Date.	ω	α	*d*	Observer.
1898.	°				1898.				
Sept. 16	197	50	−250	Phillips.	Nov. 18	217	56	−187	Antoniadi.
„ 24	95	8?	−242	Stanley Williams.	„ 19	196, 219	56	−186	Molesworth.
„ 28	340, 352	43	−238	Molesworth.	„ 21	194	65	−184	Phillips.
„ 30	324	43	−236	Molesworth.	Dec. 7	52	54	−168	Phillips.
Oct. 1	309, 321	52	−235	Molesworth.	„ 17	309	55	−158	Phillips.
„ 2	298, 308	61	−234	Molesworth.	„ 20	269, 284	42	−155	Antoniadi.
„ 6	262, 272	54	−230	Molesworth.	„ 20	276	50	−155	Phillips.
„ 9	235, 257	50	−227	Molesworth.	„ 21	249, 268	42	−154	Antoniadi.
„ 11	223	50	−225	Molesworth.	„ 22	270, 277	43	−153	Antoniadi.
„ 12	207, 218	53	−224	Molesworth.	„ 25	245	45	−150	Phillips.
„ 13	204	57	−223	Molesworth.	„ 26	262	37	−149	A. A. Williams.
„ 17	163	56	−219	Molesworth.	„ 27	253	27	−148	Corder.
„ 18	147, 159	56	−218	Molesworth.	„ 31	180	47	−144	Phillips.
„ 19	140, 152	59	−217	Molesworth.	1899. Jan. 4	153	43	−140	Phillips.
„ 22	123, 131	60	−214	Antoniadi.	„ 4	167	35	−140	A. A. Williams.
„ 27	70, 82	54	−209	Molesworth.	„ 4	171	42	−140	Hall.
Nov. 3	356, 8	53	−202	Molesworth.	„ 8	101, 116	42	−136	Antoniadi.
„ 4	359	75	−201	Phillips.	„ 8	118	43	−136	Phillips.
„ 6	315, 336	51	−199	Molesworth.	„ 9	85, 92	56	−135	Antoniadi.
„ 9	276, 306	50	−196	Molesworth.	„ 9	87	56	−135	Crowley.
„ 11	271, 295	55	−194	Molesworth.	„ 13	48, 63	30	−131	Corder.
„ 11	297, 306	55	−194	Antoniadi.	„ 13	59	50	−131	Phillips.
„ 13	258, 267	54	−192	Molesworth.	„ 14	32	30	−130	Corder.
„ 17	211, 237	56	−188	Molesworth.	„ 14	59	50	−130	Hall.

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Date.	ω	α	d	Observer.
1899.				
Jan. 14	73	53	−130	Phillips.
„ 16	36	25	−128	Brown.
„ 19	{331 / 0}	38	−125	Corder.
„ 22	319	32	−122	Corder.
„ 23	330	25	−121	Brown.
„ 23	332	35	−121	A. A. Williams.
„ 24	321	25	−120	Killip.
„ 24	357	54	−120	Phillips.
„ 25	285	27	−119	Brown.
„ 25	{309 / 328}	50	−119	Antoniadi.
„ 25	292	38	−119	Mee.
„ 26	273	30	−118	Corder.
„ 26	280	27	−118	Brown.
„ 26	288	48	−118	Attkins.
„ 26	306	37	−118	Killip.
„ 26	314	34	−118	A. A. Williams.
„ 27	268	32	−117	Mee.
„ 27	330	40	−117	Kempthorne
„ 28	{228 / 236}	43	−116	Antoniadi.
„ 30	301	50	−114	Phillips.
Feb. 1	{210 / 272}	55	−112	Phillips.
„ 1	224	35	−112	Corder.
„ 1	225	28	−112	Brown.
„ 1	264	24	−112	Townshend.
„ 2	205	33	−111	Kempthorne
„ 2	235	34	−111	Mee.
„ 2	{242 / 257}	46	−111	Antoniadi.
„ 2	251	36	−111	Hall.
„ 2	259	37	−111	A. A. Williams.
„ 3	206	36	−110	Hall.
„ 3	234	43	−110	Attkins.
„ 3	255	38	−110	Kempthorne.
„ 4	{214 / 225}	46	−109	Antoniadi.
„ 7	196	35	−106	Corder.
„ 10	{153 / 201}	41	−103	Antoniadi
„ 10	{158 / 203}	46	−103	Crowley.
„ 12	156	36	−101	Hall.
„ 14	91	52	− 99	Phillips.
„ 16	72	28	− 97	Corder.
„ 17	{79 / 109}	42	− 96	Antoniadi.
„ 17	86	46	− 96	Crowley.
1899.				
Feb. 17	{106 / 130}	30	− 96	Attkins.
„ 20	{28 / 38}	48	− 93	Antoniadi.
„ 21	35	38	− 92	Kempthorne.
„ 22	58	35	− 91	Killip.
„ 23	57	48	− 90	Stanley Williams.
„ 23	60	37	− 90	Kempthorne.
„ 23	71	35	− 90	Attkins.
„ 24	{42 / 60}	42	− 89	Antoniadi.
„ 24	42	27	− 89	Attkins.
„ 25	{24 / 39}	40	− 88	Antoniadi.
„ 26	29	44	− 87	Phillips.
„ 26		37	− 87	A. A. Williams.
„ 27	{320 / 16}	40	− 86	Antoniadi.
„ 27		25	− 86	Attkins.
Mar. 1	32	38	− 84	Phillips.
„ 2	309	30	− 83	Attkins.
„ 5	325	26	− 80	A. A. Williams.
„ 10	290	48	− 75	Phillips.
13	266	26	− 72	Killip.
„ 14	189	35	− 71	Antoniadi.
„ 14	{207 / 255}	26	− 71	Attkins.
„ 14	249	40	− 71	Phillips.
„ 15	178	30	− 70	Killip.
Mar. 16	178	36	− 69	Antoniadi.
„ 27	124	30	− 60	Attkins.
Apr. 3	70	32	− 53	Phillips.
„ 9	337	32	− 47	Phillips.
„ 19	{254 / 261}	30	− 37	Antoniadi.
„ 21	245	26	− 35	Phillips.
May 27	257	26	+ 3	Antoniadi.
„ 30	{217 / 228}	25	+ 6	Antoniadi.
June 1	194	27	+ 8	Antoniadi.
	189	36?	+ 9	Antoniadi.
„	72	22	+ 10	Molesworth.
„ 7	{30 / 40}	29	+ 14	Molesworth.
„ 8	23	28	+ 15	Molesworth.
„ 10	4	25	+ 17	Molesworth.
„ 11	356	25	+ 18	Molesworth.
„ 12	345	23	+ 19	Molesworth.
„ 13	332	23	+ 20	Molesworth.

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Date.	ω	α	δ	Observer.	Date.	ω	α	δ	Observer.
1899. June 16	300	21	+ 23	Molesworth.	1899. July 9	78	25	+ 46	Molesworth.
„ 20	265	24	+ 27	Molesworth.	„ 10	70	21	+ 47	Molesworth.
„ 21	256	24	+ 28	Molesworth.	„ 15	25	20	+ 52	Molesworth.
„ 22	247	23	+ 29	Molesworth.	„ 16	11	20	+ 53	Molesworth.
„ 24	225	26	+ 31	Molesworth.	„ 17	1	20	+ 54	Molesworth.
„ 26	206	22	+ 33	Molesworth.	„ 18	354	20	+ 55	Molesworth.
„ 27	200	20	+ 34	Molesworth.	„ 19	341	19	+ 56	Molesworth.
July 6	109	19	+ 43	Molesworth.	„ 20	336	20	+ 57	Molesworth.
„ 7	95	20	+ 44	Molesworth.	„ 21	324	20	+ 58	Molesworth.
„ 8	88	21	+ 45	Molesworth.	„ 22	314	19	+ 59	Molesworth.

These data are very instructive. It is interesting to see that the N. polar cap was still considerable two months after the summer solstice.

With reference to the early veiling of this cap, Molesworth adds the following considerations:—

"A study of the September drawings at once brings us to the "conclusion that the N. polar cap, during September . . . was "partially veiled from us by some obscuring medium; dense early "in September, thinner later, and finally clearing away at the "beginning of October (rather more than a month before the "spring equinox of the N. hemisphere). This obscuring medium, "I think we may assume to have been the clouds and mists of "the winter of the Martian N. pole, which covered the latter "during the process of formation, and remained covering it until "the melting of the edge of the polar cap had begun in the early "spring. If this assumption is correct, we have a strong analogy "between Mars and the earth in this respect.

"Referring to the 1896 'Report' we find that a fog-like ap- "pearance covered the edge of the N. polar cap from November "18th to early in December, about a month before the spring "equinox of the N. hemisphere.

"It will also be noticed that this year the *Maria* began to "darken again eight days before the first unveiling of the polar "cap, which would appear to point to an intimate connexion "between the two phenomena. If the irrigation theory is correct, "this might be due to the springing-up of vegetation fertilised "by the earliest flow of water from the incipient melting of the "polar cap."

The cap was seen "slightly indented at $\Omega = 310 - 315$," on December 19 by Phillips, and "flattened on *f* side," February 17, $\omega = 78°$ by Attkins. Its colour was, according to the former observer, an intense bluish white, like Vega.

Lastly, with reference to the dark band encircling the cap, Attkins and Townshend write that it was seen of "a very dark blue" at first, and that the colour faded with the season. This statement is confirmed by Hall when writing that "on February "21, while *Mare Acidalium* was dark, the 'sea' surrounding the "polar cap was considerably lighter than it was a month before."

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PART III.

CONCLUSION.

Chart of Mars in 1898–1899.

The Chart at the end of the present "Report" is a combination of the results given in the drawings supplied by the Members of the Section. The process of combination was an arduous one. Notwithstanding, however, the arbitrary character of the task, the Director believes that the present Chart of Mars constitutes, by the mutual corroboration of most of its data, the most solid and trustworthy delineation of the planet made during the last apparition.

The Section tenders its warmest thanks to Mr. A. C. D. Crommelin, B.A., F.R.A.S., of the Royal Observatory, Greenwich, for his excellent "Ephemeris for Physical Observations of Mars, 1898–1899," published in Vol. LVIII. of the "Monthly Notices" of the Royal Astronomical Society, without which our work would have been assailed by formidable difficulties. The last column of the Ephemeris, the one concerning the passage of the Zero Meridian, was found in fair agreement with the appearance of the planet, and its difference was smaller than the errors of observation. Hence the justification for taking *Fastigium Aryn* as the Martian Greenwich on the Chart. Meantime, the measures of position taken by the Director on the most striking markings (*Sinus Sabæus*, *Mare Acidalium*, *Titanum Sinus*, *Trivium Charontis*, N. point of *Syrtis Major*, &c.) have shown (*a*) the accuracy of Prof. Schiaparelli's charts, and (*b*) the absence of any appreciable changes in the position of the dark areas. The backbone of the Chart is thus as accurate as could reasonably be expected.

It was thought advantageous to depart from the system followed in previous years, by drawing the Chart on a large scale, and printing it in such a manner that the reader might, by unfolding it, have at the same time text and map before him. This avoids turning pages, and enables to find the markings described at a glance.

The Chart contains the following abbreviations:—I. = *Insula*; *L.* = *Lacus*; *Prom.* = *Promontorium*. White spots are indicated by dotted circles. Markings conveying the idea of "land" are generally written in *upright* letters, those interpreted as meaning "water" in *inclined* letters. The names of important objects, not visible in 1898–1899, are given in brackets, while names belonging to Lowell's (1894) and Cerulli's (1899) maps, are indicated in inverted commas. The same is the case with names introduced by the Director. Overcrowding has been avoided by the use of *part* only of Schiaparelli's nomenclature, namely, those names which have been judged indispensable to the features presented by the last apparition.

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The 1898–1899 Changes on Mars.

As shown in the exposition of the observations, these were—

(1) The incontestable intensification of the *Boreosyrtis*, invading, with a dark material, all the country to the E., until *Phlegra*;

(2) The separation between the *Syrtis* and *Nilosyrtis*, visible since 1896–1897;

(3) The development of "*Solis Pons*," resulting in a separation between the *Syrtis Major* and the *Sinus Sabæus*;

(4) The reappearance of *Nix Atlantica*;

(5) The remarkable "hour-glass" form of the "*Hour-glass Sea*."

On some Points connected with the Physical Constitution of Mars.

With a few exceptions, the following considerations lay no claims to originality:—

(1.) The question of the age of Mars is beyond our present grasp. Were the planet young, and its surface still warm, there would be no condensation caps at the poles, while, on the other hand, observation is reluctant to making of Mars a glacier.

(2.) The atmosphere is much more transparent than it is generally supposed to be, allowing, at times, markings on the limb to be seen quite as sharp and dark as when on the central meridian. Probably its density is also very small. It is not certain that clouds do float in such a medium. But superficial condensations (like hoar frost) are highly probable.

(3.) Should Dr. Johnstone Stoney's theory of the absence of aqueous vapour be correct, then the mean temperature of the planet would be low, harmonising, indeed, more readily with the demands of the law of inverse squares. If the theory be incorrect, and the polar caps be due to ordinary snow, then the mean temperature would not seem to be far from the 0° Centigrade. To ensure, however, such a result, the Martian atmosphere ought to contain some gas, fairly diathermanous to the luminous heat of the sun, but strongly athermanous to the reflected dark radiation from the surface. In that case only could the planet be habitable in the sense we are giving to that term.

(4.) Inasmuch as contrast ought necessarily to brighten regions approaching the limb (which, on Mars, entails an apparent change of colour from ochre to white), the phenomenon of the lands whitening with the obliquity of the visual (or solar) rays, must, to some extent at least, be subjective. If essentially objective, we have in it evidence of a considerable absorption of the solar rays by the Martian atmosphere, since, under an

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increasing thickness of the gaseous envelope, the solar beam is too enfeebled to prevent precipitation.

(5.) The valuable results secured by the Section can now throw some light on the points raised by our late lamented past President, Mr. Green, at the December 1890 Meeting of the Association. There is no questioning the splendid accuracy of Prof. Schiaparelli's *outlines* of the *Maria*, but Mr. Green was right in stating that the Italian astronomer had a slight tendency to turn "soft and indefinite pieces of shading into clear, sharp, "lines." We know, at present, that the continental regions of Mars, and the N. hemisphere especially, are diversified by extensive, though exceedingly faint shadings, of almost all degrees of delicacy, visible to some observers, invisible to others, but on whose objective reality no reasonable doubts could be entertained.

(6.) From an analysis of past work, but chiefly from Rev. P. H. Kempthorne's valuable observations given in this "Report," we now know for certain that a considerable number of the so-called "canals" coincide with the boundaries of adjacent areas of different *albedos*. The fact is significant.* Generalising, however, on this point, by considering *all* the canals to be edges of shades, would be dangerous at present. But great credit is due to Mr. Maunder for having suggested this explanation for *some* canals almost 20 years ago.

(7.) The evidence in favour of objective change on Mars, beyond the obvious melting of the snows, is strong. A single instance, drawn from the present "Memoir" will suffice to illustrate this. In 1883–1884 the *Boreosyrtis* was a narrow dark band, surrounded by a bright area. In the comparable opposition of 1898–1899, a prodigious mass of dark material covered at least 10 times the area of the 1883–1884 band. Obviously, such discrepancies, seem far outside observational errors. And if change occur on such a gigantic scale on a given point of the planet, it is likely to affect, in a more or less attenuated form, all other parts of the Martian surface.

(8.) But little aquatic is the deportment of the *Maria*. Variability of intensity and outline are not the characteristics of water areas.

(9.) "Lakes" forming on the intersection of widening canals are not necessarily real, but might be superposition images ("Journal," Vol. XI., No. 1). Of course, this interpretation does not apply to real, permanent markings, but simply to some exceedingly small dots, invisible when the canals are narrow, but visible only when the breadth of the latter is increasing.

* In this connexion, the following extract from the report of the Meeting above alluded to is eloquent:—"Mr. Green added that he had himself been "deceived sometimes by the edges of large faint tones, and had drawn them "with a single line, only to find out his mistake when the form came to the "meridian, and its whole shape was made evident."—"Journal," Vol. I., p. 113.

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(10.) As shown by Mr. Stanley Williams, the doubling of the markings cannot be accounted for by M. de Boë's hypothesis of out-of-focus vision, which the Director advocated in 1898, but in order to abandon early in 1899, when his experiments on very fine lines which it was impossible to "double," led him to fatal objections. In Vol. VIII., p. 309 of the "Journal," the Director wrote that "if a canal is at the limit of visibility when "at focus, its doubled and weakened image would not "impress the retina," and, since that time, he often asked himself whether *all* the canals being at the limit of visibility, their doubled images would not be invisible. He published, however, nothing on this point, but simply sought another explanation of the phenomenon.* The credit, therefore, of first drawing attention to this objection in print belongs entirely to Mr. Williams, who, in a series of valuable papers published in 1900 in the "Journal," completely overthrew the optical theory of M. de Boë. Viewed in a powerful telescope, the double markings have the appearance of objective realities, but, whether the canals are actually doubling, as affirmed by Prof. Schiaparelli, or are grouped into more or less permanent pairs—like some of the bright streaks radiating from Tycho and other large walled plains on the moon —is what future observation only will decide.

In concluding the present "Report," the Director wishes to express his sense of gratitude for the valuable collaboration given by the gentlemen who worked with such perseverance and skill under the uninviting conditions of out-door nightwork in mid-winter; and to congratulate them on the success which crowned their efforts in increasing our knowledge of our neighbour in space.

E. M. ANTONIADI,
Director of the Section.

Observatoire Flammarion,
Juvisy (S.-et-O.), France,
1901, January 2.

* "English Mechanic," Vol. LXIX., No. 1770, p. 37.

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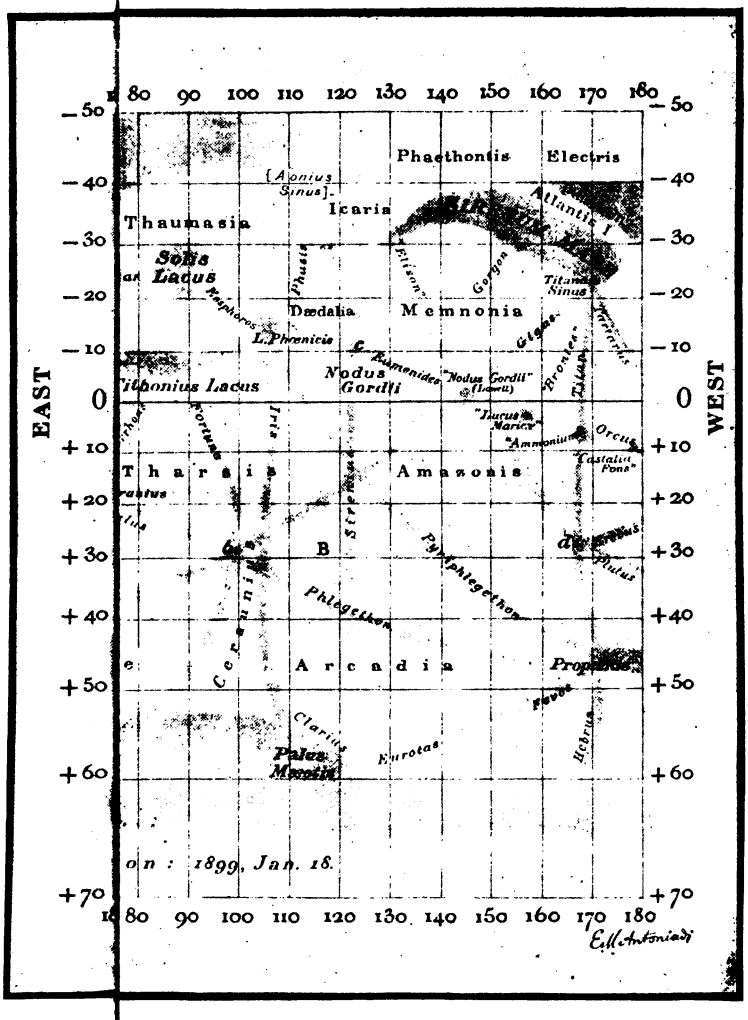

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MARS 1898–99

Plate 1.

Fig 1. H. Corder. $6\frac{1}{2}^{in}$ Spec.
1899. Jan. $19^d\,9^h30^m$ $\omega=0°$ $\phi=-11°5$

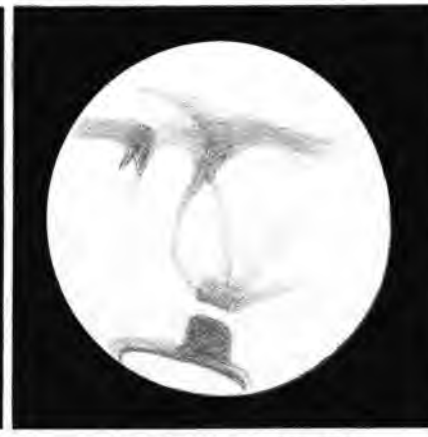

Fig 2. E. M. Antoniadi. $10\frac{1}{2}^{in}$ O.G.
1899. Feb. $20^d\,6^h11^m$ $\omega=28°$ $\phi=+8°5$

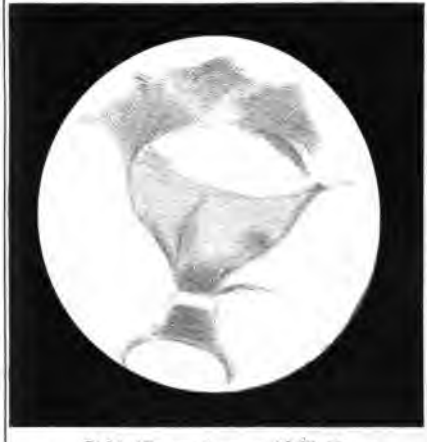

Fig 3. P. H. Kempthorne $12\frac{1}{2}^{in}$ Spec.
1899. Feb. $21^d\,7^h15^m$ $\omega=35°$ $\phi=+8°5$.

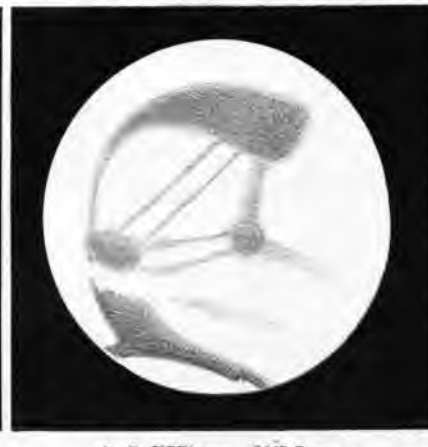

Fig 4. A. S. Williams. $6\frac{1}{2}^{in}$ Spec.
1899. Feb. $23^d\,10^h\,0^m$ $\omega=57°$ $\phi=+8°6$.

Fig 5. L. A. Crowley 7^{in} O.G.
1899. Feb. $17^d\,8^h20^m$ $\omega=86°$ $\phi=+8°6$

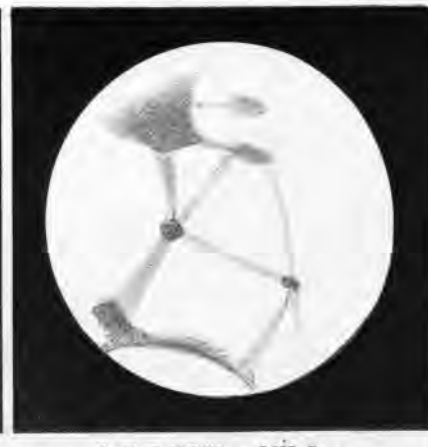

Fig 6. T. E. R. Phillips. $9\frac{1}{4}^{in}$ Spec.
1899. Feb. $14^d\,6^h15^m$ $\omega=91°$ $\phi=+8°7$.

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Fig.1. P.B.Molesworth. 12½in Spec.
1898. Oct.22d10h46m ω-121° ρ-13°9

Fig.2. P.B. Molesworth. 12½in Spec.
1898. May.25d11h50m ω-143° ρ-20°

Fig.3. T.E.R.Phillips. 9¼in Spec.
1899. Jan.4d11h0m ω-153° ρ-13°8

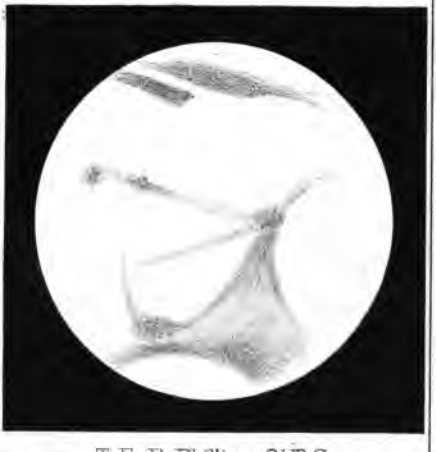

Fig.4. T.E.R.Phillips. 9¼in Spec.
1898. Dec.31d10h15m ω-180° ρ-14°4

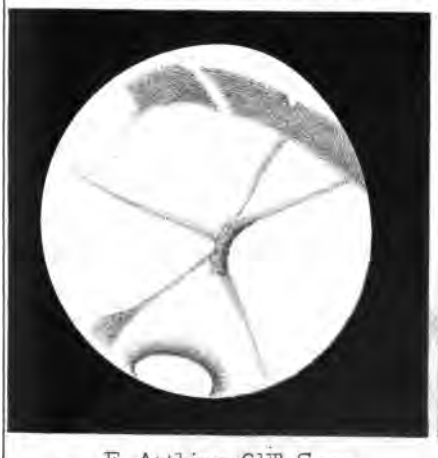

Fig.5. E.Attkins. 6½in Spec.
1899. March14d7h35m ω-207° ρ-9°6.

Fig.6. G.L.Brown. 10½in Spec.
1899. Feb.1d7h59m ω-225° ρ-9°7

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MARS 1898–99. Plate 3.

Fig.1. W.J. Hall. $4\frac{7}{8}^{in}$ Spec.
1899. Feb. $2^d 10^h 25^m$. $\omega = 25°$. $\phi = +9°5$

Fig.2. A.A. Wilhams. 5^{in} Spec.
1899. Feb. $2^d 11^h 0^m$. $\omega = 259°$. $\phi = +9°5$.

Fig.3 H.J. Townshend. $9\frac{1}{2}^{in}$ Spec.
1899. Feb $1^d 10^h 45^m$. $\omega = 264°$. $\phi = +9°7$.

Fig.4. A. Mee. $8\frac{1}{2}^{in}$ Spec.
1899. Jan. $25^d 8^h 25^m$. $\omega = 292°$. $\phi = +10°6$

Fig.5 R. Killip. 5^{in} O.G.
1899. Jan. $24^d 10^h 30^m$. $\omega = 321°$. $\phi = +10°7$

Fig.6. E.M. Antoniadi. $10\frac{1}{2}^{in}$ O.G.
1899. Feb. $27^d 6^h 51^m$. $\omega = 334°$. $\phi = +8°6$

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SECTION FOR THE OBSERVATION

OF

SATURN

DIRECTOR—G. M. SEABROKE, F.R.A.S.

REPORT OF THE SECTION.

This Section has for its Members Mr. Smart, Mr. Garrard (having a 5¼-in. refractor), Mr. Griffiths, Mr. Bullock (a 3-in. refractor), Mr. Bolton, the Rev. T. H. Foulkes, Mr. H. J. Townshend (a 10-in. reflector) Mr. C. T. Whitmell, Mr. E. Essam, and Mr. A. Mee.

Owing to the low altitude of the planet for some time past the observations of the Section are not numerous, and it is surprising that the drawings I have received are as good as they are. Again, the distance of Saturn—some 840 millions of miles—was large at the last opposition.

Mr. Townshend remarks having seen the N. pole of the planet of a deep orange colour, and Mr. C. T. Whitmell has contributed a paper showing, on theoretical grounds, how certain parts of the planet may be coloured owing to the dispersion of light in traversing our atmosphere.

Mr. Townshend says the belts were not observed last year as triple, but only double, and Mr. Stanley Williams remarks on his seeing two faint and diffuse belts just N. of the bright equatorial zone.

Mr. Garrard, who sends a drawing, also concurs in seeing two belts only, which were on most nights seen as a broad shading.

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Mr. Bolton has made some remarkably fine drawings of the planet, one of which is here reproduced (Fig. 1).

FIG. 1.

The point worthy of chief note is that the outline of the shadow of the globe where it crosses the rings is not a continuous line, but is broken into a step such as would be formed were the surfaces of the rings not at the same level. This feature is shown as existing in the several drawings appearing on Fig. 2, on various dates.

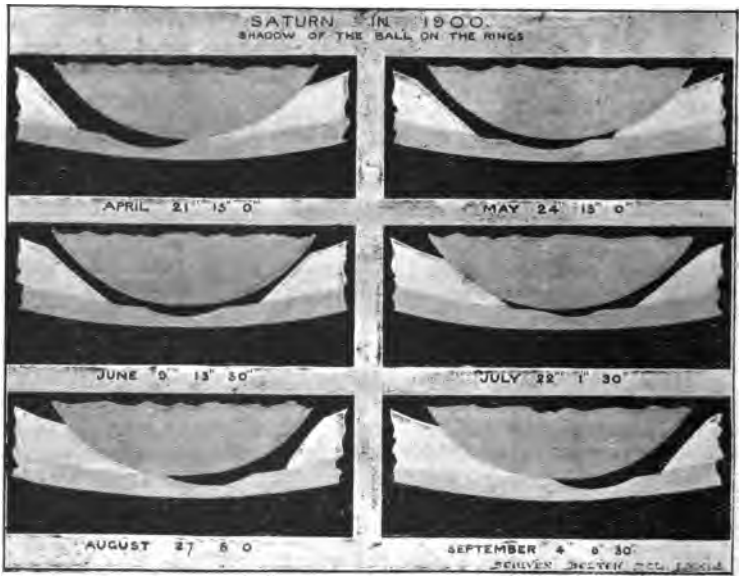

FIG. 2.

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It might also be caused by the outer ring being thicker than the next; on either of these hypotheses suggested by Mr. Bolton the observations might be accounted for. The diagrammatic plan seen on Fig. 3. explains more fully the appearances on either hypothesis.

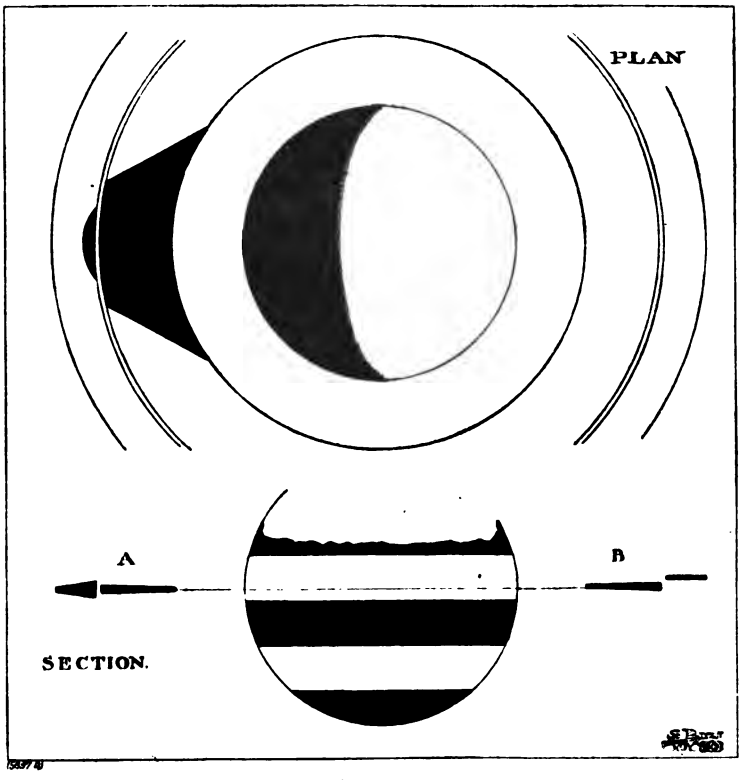

FIG. 3.

A shows the explanation on the assumption of a thickened ring, and B with the outer ring raised above the plane of the middle ring. Something of the same sort has been observed before, and has been thought to be due to irradiation, but it is no new thing to allege that the rings do not lie on the same plane, though the evidence is anything but conclusive. From the fact that the rings disappear, or nearly so, when seen edgewise, it is scarcely probable that one can be so much thicker than the other as to cause the appearance in question, and one must suspect the effect to be an optical one.

In a paper to the Royal Astronomical Society, by M. C. Flammarion, January 1901 (**M.N.**, Vol. 61., No. 3), the writer remarks that the shadow of the planet had an irregular outline owing to the varying luminosity of the ring. Irradiation caused it to appear to turn round in a sharp curve into the Cassini division. His sketch shows a very similar phenomenon to that of Mr. Bolton, and both are evidently due to the same cause.

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The curves of the outline of the shadow of the ring on the planet have been studied by Mr. C. T. Whitmell, and the forms of such curves at various inclinations of the ring to the sun and earth have been set forth in his paper, printed in the "Journal," Vol. X., pp. 67–71. A problem in sphero-conics is involved, which Mr. Whitmell solves in the paper in question, and shows that in certain cases the outline is a curve of double curvature, which, at first sight, is not to be expected.

On pages 198–202 of Vol. XI. of the "Journal," will be found Mr. Whitmell's discussion of the times taken for the immersion and emersion respectively during an occultation of Saturn, with an explanation of the reasons for the differences, and on pages 34 and 35 will be found Mr. Newbegin's and Mr. Astbury's observations of the occultation of 3rd September 1900, which gave rise to Mr. Whitmell's paper.

REPORT OF MR. J. GARRARD USING A 5¼-IN. ACHROMATIC REFRACTOR,

Equatorially mounted at Louth, Lincolnshire, Long. 0° 0′ 0″, *Lat.* 53° 22′ *N.*

Saturn in 1900 has been a disappointing object to observe. Its low elevation above the horizon, combined with a run of poor observing weather, has rendered most observations nearly useless.

One comprehensive drawing has been made from sketches and notes on the best nights. It shows all that could be seen at any time distinctly.

Cassini's division was generally seen on clear nights in the extremities of the ellipse. On a few of the best nights it was clearly traced *all round.*

The shadows of the ball on the ring and of the rings on the ball were generally well seen, and, on best occasions, of great sharpness on their edges, appearing clean cut.

The equatorial double belt was on most nights seen as a single broad shading, rather faint, but on two or three occasions was distinctly to be seen double.

The illumination of the inner bright ring was the most brilliant of the whole system on all occasions. This ring seemed to fade off in brilliancy towards its inner edge. The outer ring beyond Cassini's division was always darker, and generally the *darkest* portion of the entire system, being almost as dark as the equatorial belts. The ball of the planet was intermediate between the inner and outer bright rings in brilliancy. The lower (N.) portion was observed as darker than the S. (January 24th and other dates).

The Crape Ring was not seen with certainty.

The colour of Saturn and his system as a whole seemed a pale nondescript yellow, or dirty white. Especially was this the case on the occasions of the occultations, when the light of the moon was available for comparison. No other colour was noted on any part of the ball or rings. The equatorial belts appeared to be merely faintly shaded by neutral grey.

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The Satellites were not critically observed, nor was any attempt made to identify them, and although Saturn passed at one time before a thick cluster of telescopic stars, no attempts were made to measure or time near approaches or contacts, either of planet or satellites, with any of the stars.

Observations that call for particular note were:—

June 13th 1900.—Occultation. The disappearance was missed on account of clouds. Re-appearance was noted to commence at 9.53 p.m. Planet came quite sharply from the dark limb, showing not the slightest distortion or dimness to the very edge of the moon. Its colour, by contrast with the moon, seemed much fainter and paler, and of a dirty parchment colour.

July 1st.—The equatorial belt was seen double. Its components were very sharply edged, and narrow.

July 24th.—Definition nearly perfect; power 160. Equatorial band shown clearly double and quite sharp. Cassini's division seen all round. Outer edge of outer ring seemed much shaded. N. part of ball seemed darker than S.

July 28th.—Cassini's division seen easily all round. Equatorial band clearly double.

August 14th.—Heavy dew. Best view of season. Cassini's division has a jet black line all round, plainer than it was ever seen from here before. Equatorial belt clearly defined and double, but very pale and delicate. N. edge of ball bordered by its shadow. Edge of shadow seemed just to leave none of the ring visible beneath it. Edge of ring and edge of shadow appeared in contact.

September 3rd.—The other occultation could not be properly observed for mist.

No other observations were worth noticing, notwithstanding the fact that the planet was observed on nearly every available night.

REPORT OF MR. H. J. TOWNSHEND, OF LEEDS, USING A 10-IN. REFLECTOR.

On the night of opposition, 23rd June 1900, Saturn was not visible, being completely obscured by clouds. I got my first good view of him on July 10. I saw Cassini's division at the ansæ only, and the C ring very narrow and not distinct, but I saw the shadow of the ball upon the ring system at the N.E. evenly again all around the planet's N. pole.

On July 15, at $10^h\ 45^m$, I obtained my best view of the planet. Cassini's division was seen all round, except where interrupted by the shadow of the ball upon the ring system, and this shadow was again perpendicular to the N. pole, and Cassini's division was tangential to the N. pole—I should say exactly so, this opposition. At the opposition of 1899 Cassini's division was clearly *below* the level of the N. pole. The shadow of the rings upon the southern region of the ball was distinct this year, and the C ring was

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fairly well seen, moderately broad and dark, against the B ring. I could not make the belts triple this year, but I discerned an oblong dark marking on the N. preceding side, well within the belt system. In previous years I have *always* seen the belt system triple, as if they were N. equatorial belt, S. equatorial belt, and equatorial belt, similar to Jupiter's system of equatorial belts, with this difference, that, in the case of Jupiter, the N. and S. equatorial belts are both broad, and the equatorial belt fine and narrow; whereas in the case of Saturn they seem to me all of uniform width. I think I failed to see the triple set of belts only because of the great distance of the planet, with low altitudes, obscuring the disc in the smoky atmosphere of Leeds.

With respect to my idea of the Saturnian equatorial belts being similar to Jupiter's, but all of uniform width, instead of, as in Jupiter's case—two wide, *i.e.*, north and south, and one very fine, line-like, *i.e.*, the equatorial—I always saw them triple, and placed fairly in the planet's centre, and at uniform distances apart. I did not see the three belts this last opposition, I believe, for reasons stated above, but I observed Saturn only seven times altogether. The planet's great distance and low altitude made him a very difficult object for me.

In 1899 I saw the N. pole of the planet of a deep orange colour. This may have been due to atmospheric dispersion of light.* The ring system being below the N. pole of planet may overpower that region, and so give it that colour. I believe such a phenomenon could not occur to either sun, moon, or any other planet without the ring system, and then only with Saturn when the ring system is below the planet's N. pole. Without the ring system the N. pole of sun, moon, or planet is, I believe, always blue, by dispersion of light, when at a low altitude. The last time I saw Saturn's equatorial belts triple was on 15th and 17th June 1899.

REPORT OF MR. A. MEE, AT CARDIFF, USING AN 8½-IN. REFLECTOR.

Occultation of Saturn, September 3, 1900, observed under very fair conditions considering the low altitude of Saturn. Definition not good enough to make any note on behaviour of image at moon's limb. The time of bisection was, as nearly as possible, at ingress, $8^h\ 7^m$. The effect of the occultation by the moon's invisible dark limb was striking. Comparison of colours:—Moon bright golden, Saturn zinc; power 60.

COLOUR ON THE PLANET.

MR. C. T. WHITMELL offers the following explanation of the colour of certain areas on the planet.

Assume, for simplicity, that a planet is on the meridian, so that its N. limb is at the top and its S. limb at the bottom.

When a planet's altitude is low, the N. limb may appear blue, the S. limb orange, owing to atmospheric dispersion.

* This explanation was furnished by Mr. Whitmell.

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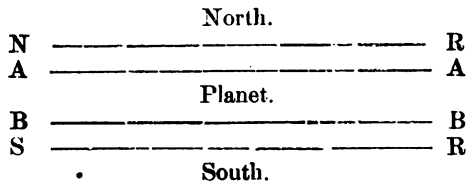
But, in the case of Saturn, the bright rings complicate the matter.

In the figure (diagrammatic) N R and S R are the N. and S. external limits of the ring system. A A and B B are the N. and S. apparent common meeting lines (as it were) of ring and planet.



Dispersion, acting on the ring-light, will colour N R blue and A A orange; also B B blue and S R orange. Dispersion, acting on the planet light, will not affect N R or S R, but will make A A blue and B B orange.

Now A A will be orange from ring dispersion, but blue from planet dispersion; whilst B B will be blue from ring dispersion, but orange from planet dispersion. Were ring and planet equally bright, A A and B B would not exhibit colour, the dispersions compensating each other. But as the ring is brighter than the planet, it is possible that A A will have an orange and B B a bluish tinge, that is to say, colours just the opposite of what would be the case were the ring absent, so that Saturn could be seen isolated like Jupiter. I think that in estimating the colour of the N. and S. region of Saturn at low altitudes, this possible effect of the ring should not be overlooked.

On the moon I have seen peaks, which were brighter than the illuminated lunar surface surrounding their bases, show distinct dispersion colours. I should be glad if observers with good telescopes will observe Saturn for dispersion colours, and let me hear the results.

About the time of the northern summer solstice of Saturn, I should expect the dispersion of ring-light to produce its principal effect on the southern region of the planet, because the bright B ring then passes near a southern zone darkened by the C ring. With the planet at a moderate altitude this zone may be expected to show a bluish tint.

At the same season, the A ring is adjacent to the planet's N. pole. This ring is dimmer than the B ring, but must still be brighter than the planet's polar region, if the orange colour of the latter resulted from dispersion; for, if the ring were absent, dispersion would colour the region blue. The bright B ring may affect the limb of the planet just S. of its N. polar region.

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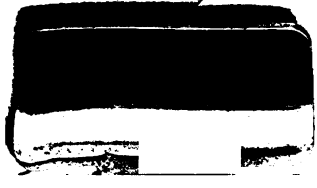

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